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U. S. DEPARTMENT OF AGRICULTURE

BIOLOGICAL SURVEY — BULLETIN No. 31

C. HART MERRIAM, *Chief*

AN ECONOMIC STUDY OF FIELD MICE

(GENUS *MICROTUS*)

BY

DAVID E. LANTZ

ASSISTANT, BIOLOGICAL SURVEY.

WASHINGTON
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1907

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey,
Washington, D. C., August 1, 1907.

Sir: I have the honor to transmit herewith, as Bulletin No. 31 of the Biological Survey, an economic study of field mice, by David E. Lantz. Field mice are so generally distributed throughout the United States and at times are so numerous in certain regions that they do serious damage to gardens, nurseries, orchards, and forests. The several species therefore possess an economic importance quite out of proportion to their size. The present bulletin gives a concise account of their distribution and general habits, the nature of the damage they do, together with methods of prevention, the best means of limiting their increase under ordinary circumstances, and of reducing their numbers when, by reason of excessive multiplication, the injuries they inflict are serious.

Respectfully,

H. W. Henshaw,
Acting Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.
Introduction ---- 5
Classification of field mice ---- 8
  Species and distribution ---- 9
Habits of field mice ---- 10
  Nests and trails ---- 10
  Breeding habits ---- 11
  Food habits ---- 13
Three typical species ---- 15
  I. The common meadow mouse (*Microtus pennsylvanicus*) ---- 15
  II. The prairie mouse (*Microtus ochrogaster*) ---- 18
  III. The pine mouse (*Microtus pinetorum scalopsoides*) ---- 19
Damage by field mice ---- 22
  Damage to meadows and pastures ---- 22
  Damage to grains and forage ---- 23
  Damage to garden crops ---- 23
  Damage to small fruits ---- 24
  Damage to nursery stock ---- 24
  Injury to orchards ---- 25
  Injury to forest trees ---- 26
  Damage to parks and lawns ---- 27
Studies in an orchard ---- 27
The relation of field mice to the farmer ---- 30
  Reports from farmers and others ---- 30
  Reports from nurserymen and orchardists ---- 33
  Economic status of field mice ---- 37
Repression of field mice—natural agencies ---- 37
  Climatic influences ---- 37
  Epidemic diseases ---- 38
  Natural enemies of field mice ---- 38
    Mammals that destroy field mice ---- 39
    Birds that destroy field mice ---- 42
    Snakes ---- 53
Repression of field mice—active measures ---- 54
  Trapping ---- 54
  Cultivation ---- 55
  Other mechanical devices ---- 56
  Poisoning ---- 56
    Strychnine ---- 56
    Other poisons ---- 57
    Additional methods of poisoning ---- 59
  Fumigation ---- 59
  Micro-organisms ---- 60
Recommendations to farmers ---- 60
  Prevention of injury to orchards and nurseries ---- 60
  Remedies for injured trees ---- 62
  Summary ---- 63
Literature ---- 64

265045

ILLUSTRATIONS.

PLATES.

Page.
I. Fig. 1.—Meadow mouse (*Microtus pennsylvanicus*). Fig. 2.—Pine mouse (*Microtus pinetorum scalopsoides*) 16
II. Roots of wild morning-glory stored by meadow mice 16
III. Fig. 1.—Young apple tree eaten by pine mice. Fig. 2.—Young apple tree eaten by meadow mice 24
IV. A neglected young orchard in winter 24
V. Fig. 1.—Pear tree injured by meadow mice. Fig. 2.—Apple tree injured by meadow mice 24
VI. Fig. 1.—Low-headed apple tree in a Kansas orchard. Fig. 2.—Apple tree recovered after injury by mice 28
VII. Fig. 1.—Apple tree killed by prairie mice. Fig. 2.—Apple tree killed by rabbits 28
VIII. Apple trees girdled by prairie mice (*Microtus ochrogaster*) 28

TEXT FIGURES.

Fig. 1. Nests, burrows, and trails of *Microtus pennsylvanicus* 16
2. Field mouse caught in baited guillotine trap 54
3. Field mouse caught in unbaited guillotine trap 54

AN ECONOMIC STUDY OF FIELD MICE.[a]

INTRODUCTION.

The present paper deals with the habits of the common field mice[a] of the United States, the conditions which often favor their enormous multiplication, the natural enemies which aid in their repression, and the agencies which farmers may employ to avoid losses by the animals. Small as these pests are, they inflict enormous injury upon the crops of the country. The aggregate loss to the farmers from this source averages not less than three millions of dollars annually, and in some years is much greater. The major portion of this loss is preventable, and the object of this bulletin is to acquaint farmers, orchardists, nurserymen, and others with the most practical preventive methods.

Among the more interesting facts connected with wild animals are the sweeping changes in the relative numbers of certain species to be noticed from year to year in almost every locality. Species that are abundant one season may be rare or entirely absent the next; or they may gradually increase or decrease in numbers through a series of years until disaster results from their overabundance, or the species becomes practically extinct. Sometimes wild animals increase in numbers so suddenly that the change has been likened to a tidal wave, and ignorant people have regarded the invasion as of miraculous origin. The belief that crickets, locusts, frogs, and even mice sometimes fall from the clouds is still held in many countries.

The careful observer, however, sees little mystery in the phenomena mentioned. He has studied the general habits of animals—their food, their powers of reproduction, their migrations, the checks on their increase due to natural enemies, disease, and varying climate—and consequently he attributes sudden changes in their numbers to known causes. In such changes he recognizes, especially, the influence of man, both direct and indirect, and his responsibility for interferences that greatly modify the operations of nature.

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[a] The term "field mice" applies equally well to several groups, or genera, of mice which occur in cultivated areas and meadows of the United States, but in this paper it is restricted to the most widely known group, the genus *Microtus*.

Outside the insect world the most striking examples of occasional excessive multiplication of a species are afforded by rodents. The invasions of rabbits and rats are familiar, but no rodents exhibit the tendency more forcibly than the *Microtinæ*, a subfamily which includes lemmings, voles, and muskrats. The lemmings and voles, especially, are noted for those peculiar waves of increase that astonish observers and bring disaster in their wake. The most noted example is afforded by the somewhat periodic migrations of lemmings (*Lemmus lemmus*) in Norway and Sweden.

These animals live in the higher plateaus of Scandinavia. Here during several favorable years they increase in geometrical ratio until the food supply gives out and hunger impels great hordes to migrate into the lower valleys. Once started on their journey they continue in the same general direction in spite of all obstacles. They travel in vast armies, swimming lakes and streams, living on the products of the soil, and carrying calamity to farmers. They breed on the journey, lingering only until the young are strong enough to travel or until food is exhausted. They are constantly the prey of natural enemies which gather in their wake, and are destroyed ruthlessly by man; so that in spite of an enormous natural increase, the vast army gradually melts away. Usually disease breaks out and helps to decimate them, so that as a rule comparatively few reach the final barrier to their march, the sea. After a short delay the survivors, ignorant of the nature of the barrier, plunge into the water and essay its passage, swimming until they perish.[a] The migrations usually cover a period of two years, but are sometimes prolonged to three. None of the migrating animals return to their homes, and they are entirely absent in the lower valleys until the next migration.[b]

The economic vole (*Microtus œconomus*) of Siberia performs somewhat similar migrations. Writing of it over a century ago Thomas Pennant said: "They in certain years make great migrations out of Kamtschatka; they collect in the spring and go off in incredible multitudes. Like the *Lemmus*, they go in a direct course and nothing stops their progress, neither rivers or arms of the sea: in their passage they often fall a prey to ravenous fishes and birds, but on land they are safe, as the Kamtschatkans pay a superstitious regard for them; and when they find them lying weak or half dead with fatigue on the banks, after passing a river, they will give them all possible assistance. They set out in their migration westward. From the river Pengin they go southward and about the middle of July reach Oshotska and Judoma, a tract of amazing extent. They return again in October. The Kamtschatkans are greatly alarmed at their migrations, as they presage rainy seasons and an unsuccessful chase; but on their return, expresses are sent to all parts with the good news."[a]

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[a] Prof. Robert Collett, of Christiania, Norway, records that in November, 1868, a steamer sailed for a quarter of an hour through a swarm of lemmings which extended as far as the eye could reach over the Trondhjemsfjord. (Journal Linnean Society of London, Vol. 13, p. 33, 1878.)

[b] T. T. Somerville, Proc. Zool. Society of London, 1891, pp. 655–658. Robert Collett, Journal Linnean Soc. of London, Vol. 13, pp. 327–334, 1878.

Visitations of voles have not been infrequent in the history of the Old World. The earliest records of them are in the Bible[b] and in the works of Homer, Herodotus, and Aristotle. So serious did the Greeks consider plagues of field mice that in their pantheism they had a mouse god (Apollo Smintheus), who was invoked to avert the evil.

Invasions of field mice have not been rare in Great Britain and the Eurasian continent. Blasius records serious outbreaks on the Lower Rhine in the twenties.[c] Brehm, quoting Lenz, gives an account of one in 1856 and of another in Rhenish Hesse in 1861. Brehm himself observed hordes of the animals in 1872 and 1873 on the sandy plains of Brandenburg and in the rich corn lands of Lower Saxony, Thuringia, and Hesse.[d] The chroniclers of England—Holinshed, Stow, Childrey, Lilly, Fuller, and others—record outbreaks of mice in Essex and Kent, 1581, and again in Essex in 1648 and 1660. Later plagues occurred in parts of England in 1745, 1754, 1814, 1825, 1836, and 1863–1867. Severe outbreaks took place in Scotland in 1825, 1864, 1876, and 1892, the last so serious in its effects upon the sheep industry that the British Board of Agriculture appointed a special committee to investigate it. The report of this committee[e] is the most complete and important contribution to our knowledge of field mice thus far published.

A large portion of Hungary was devastated by field mice in 1875 and 1876. In 1875 they were observed to be very numerous in certain districts, and by the spring of 1876 they fairly swarmed in cultivated fields, so that the peasants "doubted whether they had sprung from the earth or fallen from the clouds." They devoured grain, roots, and growing vegetation—corn, potatoes, turnips, and lucern. In the fall they attacked vineyards and shrubbery, and when food was exhausted, began to eat each other. They were finally destroyed by an infectious disease, which killed them by thousands.[a]

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[a] History of Quadrupeds, by Thomas Pennant, 3d edition, vol. II, p. 195, 1793.

[b] "And the cities and fields in the midst of that region produced mice and there was great confusion and dearth in the city." I Samuel, v., 6 (Vulgate version.)

[c] Naturgeschichte der Säugethiere Deutschlands, von Johann Heinrich Blasius, p. 386, 1857.

[d] A. E. Brehm, Thierleben: Säugethiere, vol. 2, p. 390, 1877.

[e] Report of the Departmental Committee on a Plague of Field Voles in Scotland, London, 1893.

In North America, up to the present time, no such calamitous invasions of field mice have been known, although occasionally one or another species increases locally to such an extent as to amount to a plague. Of even greater consequence, however, is the steady drain on agricultural products caused by these rodents over a large part of the country when present in normal numbers.

CLASSIFICATION OF FIELD MICE.

The genus *Microtus* belongs to a subfamily of *Muridæ* known as the *Microtinæ* (formerly *Arvicolinæ*). This subfamily embraces a large number of forms of small and very similar rodents which in some respects resemble true mice, but which are readily distinguished by the robust body, thick head, short ears (whence *Microtus*), and short tail, the last exceeding two-thirds of the length of the body in but one genus, *Fiber* (muskrats).

The *Microtinæ* are divided into two groups, which are commonly distinguished under the names lemmings and voles. Externally lemmings have shorter bodies than voles, and, except in one genus (*Synaptomys*), the tail is shorter than the hind foot, and the palms and soles are without distinct foot pads (plantar tubercles). The two principal genera have the nails on the thumb strap-shaped (ligulate).

Voles have bodies less stout, tails usually longer than the hind foot, and soles and palms always with distinct foot pads. The thumb nails are pointed, not ligulate. There are four genera of voles, all having representatives in the United States, of which the two more familiar are *Fiber* (the muskrats) and *Microtus* (the field mice). The other two genera are of little importance to the farmer. The present paper deals only with the genus *Microtus*.

Voles of the genus *Microtus* are distinguished from members of the other three genera by having rootless molars at all stages of their life. *Fiber* may easily be recognized by its large size, its long, laterally flattened tail, and by its having the feet modified for swimming.

There seems to be no entirely appropriate vernacular name for the mice of the genus *Microtus*. The French call them "campagnols," the Germans "wühlmäuse." English-speaking people outside the United States call them "voles." In the United States they are variously designated as "meadow mice" or "field mice," and locally as "bear mice," "bull mice," "buck-tailed mice," "mole mice," etc. "Vole" is open to the objection that it applies equally well to three other genera and may easily be confused with "mole." "Field mice" will apply as well to other genera and subfamilies of mice, while the term "meadow mice" is not broad enough to include all the species of *Microtus.*

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[a] Report on a Plague of Field Voles in Scotland, Appendix III, p. 76, 1893.

SPECIES AND DISTRIBUTION.

Field mice of the genus *Microtus* have stout bodies, blunt, rounded muzzles, small eyes, and short ears—often completely concealed in the fur. The tail is short and hairy; the soles of the feet are naked or clothed with short hairs, and have five or six foot pads (plantar tubercles). The incisors are broad and not grooved.

The molar teeth in all members of the genus, like the incisors of all rodents, grow continuously throughout the life of the animal and do not develop roots. They are prismatic in form, and the crowns show triangular dentinal spaces surrounded by lines of harder enamel. These curious enamel patterns are of great importance in the classification of the animals, as they are but slightly affected by age and wear and are remarkably constant for each species.

About 165 living species and subspecies of *Microtus* have been recognized (1904), of which about 78 are North American.[a] Eight extinct fossil species have been described, and several of the living forms also have been found fossil.

The genus *Microtus* is of wide distribution, covering practically the greater part of the northen hemisphere outside the tropical zone—America north of the Tropics, all of continental Europe, and Asia, except its southern peninsulas. Great Britain has two species, but Ireland and the principal Mediterranean islands have none. The genus is not found in South America, Africa, Australia, or the Australasian islands. While true mice (*Mus*) are found over a large part of the range of *Microtus*, they do not extend so far northward and occur much farther southward. *Microtus* finds its most southerly extension in the Old World in Palestine and the southern slope of the Himalaya Mountains; in America, in southern Mexico and Guatemala.

The range of a single species is often remarkably great. Thus the typical form of the common meadow mouse of the United States (*M. pennsylvanicus*) occurs over a large part of at least twenty-five States, from Maine to the Dakotas and southward almost to 35° north latitude. If the five subspecies (geographic races) are included, this range is almost doubled in extent. Another species, *M. mordax*, occurs in most of the high mountains from Colorado to California and from Arizona to Alaska. The meadow vole of Great

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[a] For key to the North American species and descriptions the reader may consult N. A. Fauna No. 17, Revision of American Voles of the Genus Microtus, by Vernon Bailey, 1900.

Britain (*M. agrestis*), common from the Orkney Islands to the English Channel, is also distributed over much of northern Europe. Another closely related species, *M. arvalis*, has a still wider distribution in central and southern Europe, and, strange to relate, is found in England as a fossil.

On the other hand, some of the species of *Microtus* are of limited range, a few of them being confined to the summit of a single mountain or isolated on a single small island. The beach vole, for instance, occurs only on Muskeget Island, Massachusetts, while the Gull Island vole (*M. nesophilus*) of Great Gull Island, in Long Island Sound, was of such limited distribution that grading and excavating for fortifications probably resulted in the total extinction of the species.

The several species differ greatly in size. Including the tail, some are even shorter than the common house mouse, while others are as large as a medium-sized rat. The largest species is the Florida water rat (*Microtus alleni*), whose total length is about 320 mm. (12.5 inches). The smallest American species is the dwarf vole (*M. pauperrimus*), whose total length is 115 mm. (4.5 inches). While the tail of field mice is usually very short in proportion to total length of the animal, the various species differ greatly in this particular. The males of many species give off a strong odor, much like that of the muskrat.

HABITS OF FIELD MICE.

While the food habits of the various species of short-tailed field mice are remarkably similar, their breeding and general habits differ greatly. The variety of habitats is most striking. Some species prefer high and dry ground, while others live in low, moist places. Occasionally the same species inhabits both sorts of localities. Some species live in forests, others in the open prairies. Some burrow under the ground like moles, while others make smooth paths or trails upon its surface.

Except in cold weather, nearly all species can temporarily adapt themselves to moist surroundings; but a few seem to be almost as aquatic as the nearly-allied muskrat. This is true especially of the larger species, such as the Florida round-tailed "muskrat" (*M. alleni*) and the European water vole (*M. amphibius*), both of which swim and dive with such facility that they are popularly called "water rats."

NESTS AND TRAILS.

The nests of field mice are compact bunches or globes, composed chiefly of grass blades and other dry vegetable fibers. They are placed in depressions in the ground, in shallow burrows, or supported on grass stems above the ground. In brush piles the writer has found them nearly a foot above the ground. Sometimes they are placed under flat stones or logs or under shocks of grain. The structures are so slight that a day's sunshine will dry them out after a storm, and yet they are so compact that the animals pass the coldest weather snugly housed in them under the snow.

The nests are admirably located with respect to drainage, being so placed that they are not likely to be flooded during excessive rains, and often being in depressions of mounds made by the mice, well above the general surface of the meadows.

Trails, often of great length and worn smooth by constant use, lead to neighboring feeding grounds. As far as possible they are under shelter of old grass, fallen weeds, leaves, and other material. The trails of some species are almost entirely below the surface of the ground, and short tunnels are common with most species. At intervals burrows of varying depth occur, usually but a few inches below the surface. These lead to underground nests, to the roots of food plants, or serve only for refuge from enemies.

BREEDING HABITS.

While most surface nests are for shelter only, sometimes the young, especially of swamp species, are produced in them. However, the young of most kinds are born in underground nests and are rarely seen unless uncovered by accident. They are at first hairless and blind. When discovered in the nest the mother vole slips noiselessly away, sometimes carrying the young attached to her mammæ.

The breeding season includes most months of the year, except midwinter in cold latitudes and periods of long-continued drought. The number of litters in a year thus depends on climate, and especially upon the character and length of the winter. In temperate latitudes in normal seasons from four to six litters are produced. Even the same species in different localities differs much in this particular. That the number of young in a litter varies with the different species may be inferred from the variation in the number of teats. Some species produce normally from two to four young, others from four to eight; but the variation in the same species is remarkable, and depends partly upon climate, but probably more on the scarcity or abundance of food. The largest litter recorded by the field naturalists of the Biological Survey is thirteen, the species being the dwarf vole (*M. nanus*). The period of gestation is not positively known, but probably is about twenty days. Members of the Biological Survey have recorded finding young of the American species in the nests, or females containing embryos, in every month of the year except January and February.

European testimony proves conclusively that, like the lemmings, voles at times increase in numbers abnormally, but the causes are little understood. So rapidly do they multiply at such times that the results are astonishing. Females become pregnant within a few days after giving birth to a litter, and the number of young at a time is abnormal. The published accounts of conditions subsequent to and during such periods are highly interesting.

Dr. A. E. Brehm, quoting Blasius and Lenz, states, concerning the field mice of Germany (*M. arvalis*), that in 1822 in the district of Zabern 1,570,000 were caught in fourteen days. During the same time in the district of Nidda 590,427 were caught, and in that of Putzbach 271,941. In the autumn of 1856 there were so many voles in one district between Erfurt and Gotha that about 12,000 acres of land had to be replowed because of the destruction of the first crop. On a single large estate near Breslau 200,000 were caught within seven weeks and sold to a Breslau fertilizer factory at a pfennig (nearly one-fourth cent) per dozen. Some of the vole catchers caught 1,400 to 1,500 per day. In the summer of 1861, in the neighborhood of Alsheim, in Rhenish Hesse, 409,523 were caught. The local authorities paid 2,593 gulden (about $1,000) for their capture.[a]

Louis Figuier, the French naturalist, writing of the same species, says that the female gives birth to from eight to twelve little ones three or four times in a year, and that multiplication is so rapid at times that "whole districts have been reduced to destitution by this scourge. In 1816 and 1817 the one department of Vendée experienced a loss estimated at £120,000 [nearly $600,000], caused entirely by these animals."[b]

The common meadow mouse of the United States is one of the most prolific of our species. Estimating the normal increase at six young, with four litters in a season, and assuming that there were no checks upon the increase, the results are appalling. A single pair and their progeny in five seasons would amount to nearly 1,000,000 individuals. This calculation is under the mark, since it is based on the assumption that the young do not breed until about a year old. The animals, however, mature very rapidly, and the spring young undoubtedly breed in the fall of the same year.

If a thousand pairs of field mice survive the winter in any neighborhood, the potential conditions for a vole plague are present. If, now, instead of normal reproduction, circumstances bring about a considerable increase both in the number of young at a time and in the number of litters in a season, the probability of a plague is greatly increased. Hence the farmer needs the good offices of every creature that preys upon mice, to supplement the climatic limitations upon their increase and to aid in saving his crops.

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[a] Thierleben: Säugethiere, vol. 2, pp. 387–393, 1877.

[b] Mammalia Popularly Described by Typical Species, L. Figuier, p. 445, 1870.

FOOD HABITS.

Owing to its finely chewed condition, exact determination of the food of rats and mice from stomach examinations alone is very difficult. This is especially true of the species of the genus *Microtus*, whose molars are well adapted for grinding. So complete is the mastication and subsequent maceration of weed and grass seeds, as well as roots and grains, that the cell structure is often destroyed. A fair idea of the food can be gained, however, by a study of the animal's environment, by the color of the stomach contents when bark has been eaten, the odor of wild onions when present, the presence of starch grains revealed by the microscope, or the character of the few perfect vegetable cells that remain. The bits of stems, blades of grass, and leaves of other plants left scattered along the runways are important evidence, as also are the contents of the caches of food in the burrows.

In summer the principal food of these mice is green vegetation and unripe seeds of grain and grasses. As the season advances, ripe grain and seeds take the place of the immature; and in winter bulbous and other roots are in part substituted for stems and leaves. When convenient, and green vegetation is lacking, the bark of trees and shrubs becomes a staple food. It is mainly in winter that apple orchards and young forest trees suffer from attacks of mice. It is generally supposed that such attacks are due to the absence of ordinary food; but this is not always the case, for depredations often occur during mild, open winters when food abounds. Instances also of summer girdling of trees are well attested.

Examinations of stomachs of field mice show that, besides stems, leaves, and seeds of grasses and sedges, the animals eat nearly all kinds of bulbs, tubers, and roots, and occasionally animal food such as snails and crayfish. Outside the list of grains, vegetables, grasses, roots, and barks, which are generally known as staple food of field mice, they have been found eating strawberries and other fruits; roots of wild morning-glory (*Convolvulus sepium*), sweet clover (*Melilotus alba*), and cat-tails (*Typha latifolia*); seeds of iris and primrose (*Primula parryi*); bulbs of tulip, hyacinth, and wild onion; and the tubers of the Jerusalem artichoke (*Helianthus tuberosus*).

The quantity of green vegetation eaten by a single adult field mouse in the course of a year has been calculated at from 24 to 36 pounds. When one considers in connection with this estimate the great numbers of these animals in our meadows, swamps, and forests, the total quantity of food consumed by them appears so enormous as apparently to exceed the productive capacity of the soil. A thousand mice in a meadow would require at least 12 tons of grass or other green vegetation to maintain them for a year.

That a thousand of these small animals often inhabit a single meadow is not an extravagant estimate. Indeed, that number is often exceeded. Careful estimates made in France during 1893 placed the number in one district (Bar-sur-Seine) at 10,000 per hectare (about 4,000 per acre). In 1904, in the Department of Charente, the average number per hectare (2.47 acres) was estimated at 1,350 (540 per acre). Fortunately, conditions in America appear to be less favorable to their increase, and the natural enemies of mice have not yet been exterminated to such an extent that they fail to check the excessive multiplication of the rodents.

STORING FOOD.

European naturalists nearly all agree in stating that field mice store food for winter use and that the animals hibernate during cold weather. Brehm says that the common species in Germany (*Microtus arvalis*) collects fallen haws, juniper berries, beech mast, acorns, and nuts into its burows. During the coldest weather they fall into uninterrupted hibernation, but when mild weather returns they rouse up and feed on their stores.[a] Similar statements are made of other species and confirmed by other writers.

The most noted example of provident preparation for winter is afforded by the economic vole (*M. œconomus*) of eastern Siberia, whose migrations have already been described. These animals are said to lay up large stores of food during summer—20 and even 30 pounds of fresh roots have been found in one hoard.[b] The Kamchatkans habitually rob these stores of food for their own use—a fact which accounts for the favor with which they look upon the animal.

American voles, so far as known, do not hibernate, but are active in winter even in the far north. So thoroughly has this fact been proved by observation that it seems possible that European observers may be mistaken as to the hibernation of Old World species. The habit of storing food seems to be less common in this country than with Old World species, but it is far from rare. Caches of food are often found, which show that in times of abundance the animals store away more than is needed for immediate use.

One American species, the tundra vole (*M. operarius*), exhibits in its provident habits a resemblance to the economic vole. The animal is small, inhabiting mossy tundras of western Alaska, from Cape Vancouver north to Bering Strait and up the Yukon Valley to the boundary of the British possessions. According to E. W. Nelson, it gathers stores of small bulbous roots, sometimes placing a peck or more in a single cavity just below the surface on a mossy knoll or slope. In autumn, shortly before the first snowfall, the Eskimo women and children discover these stores by means of pointed sticks. In this way considerable quantities of food are gathered, which are boiled and eaten as a delicacy. "The boiled roots have a flavor like a boiled unripe sweet potato, and are very palatable during the long winter fare of meat and fish." [a]

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[a] Thierleben: Säugethiere, A. E. Brehm, vol. 2, p. 388, 1877.

[b] History of Quadrupeds, by Thomas Pennant, vol. 2, p. 194, 1793.

THREE TYPICAL SPECIES.

I. THE COMMON MEADOW MOUSE.

Microtus pennsylvanicus (Ord.) (Pl. I, fig. 1).

The most familiar of American species of *Microtus* is the common meadow mouse (*M. pennsylvanicus*). The average measurements of adults are about as follows: Total length, 170 mm. (6.6 inches); tail vertebræ, 46 mm. (1.8 inches); hind foot, 21.2 mm. (0.83 inch). The tail is always at least twice as long as the hind foot. The fur is long and overlain with coarse black hairs. In summer the ears overtop the fur. In winter the fur is longer, of a duller color, and almost conceals the ears. The usual color above is a dark brown, against which the black hairs are not conspicuous. This shades off gradually into gray or tawny on the under parts. The feet are small, the claws on the hind feet slightly larger than those on the front. The foot pads are 6; the mammæ 8 (4 pectoral and 4 inguinal).[b]

The vast range of this species has already been given. This mouse has its natural habitat in moist meadows and grassy borders of swamps, but it habitually extends its range into neighboring cultivated fields, waste lands, and open spaces on the border of timber lands. Wherever it occurs, it is normally the most abundant rodent. Nearly all meadows are full of the animals. On parting the thick grass almost anywhere one can find the smooth trails, and where the grass is thin they are often plainly visible. After the melting of deep snow, or where the dry grass has been burned, the network of runways is especially conspicuous to the eye. In swamps the paths cross soft mud and standing water, if shallow. When green scum, composed of minute floating plants, covers stagnant water, the trails are defined across it by streaks of clear water where the animals swim from side to side in the pools. In walking across a swamp one sometimes frightens them from the shelter of tussocks and sees them swim away or run through shallow water.

In swamps meadow mice nest in burrows in dry tussocks or in bunches of grass above the surface of the moist ground. The nests are composed of grass or fibers of weeds made into balls, loose and of coarser materials outside, but compact and of finer stuff within, each having a small opening on the side near the bottom. From this opening two or more trails diverge, one usually leading into an underground tunnel which opens at some distance from the nest. Nests intended to receive the young are lined with the softest of accessible materials, often with pappus of milkweed (*Asclepias*) or cat-tails (*Typha*). Such nests are sometimes hidden under grass, brush, or other litter, but more frequently are placed in underground burrows. The normal number of young varies from four to eight, the average being about six.

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[a] Proc. Wash. Biol. Soc., vol. 8, pp. 139–142, 1895.

[b] For dental and skull characters consult N. A. Fauna No. 17, p. 17, 1900.

The trails of meadow mice are interesting subjects for study. The animals take advantage of all sorts of shelter, especially that which is close to the ground. Under fallen leaves and weeds the trails become half tunnels. Even in the open meadow they are often entirely hidden under old grass, and their presence would hardly be suspected from any surface indications. Under the favoring shelter of piles of weeds, grass, or other litter the trails made by the animals are usually more intricate than elsewhere. The accompanying sketch (fig. 1) was made from trails and nests uncovered by removing a pile of weeds.

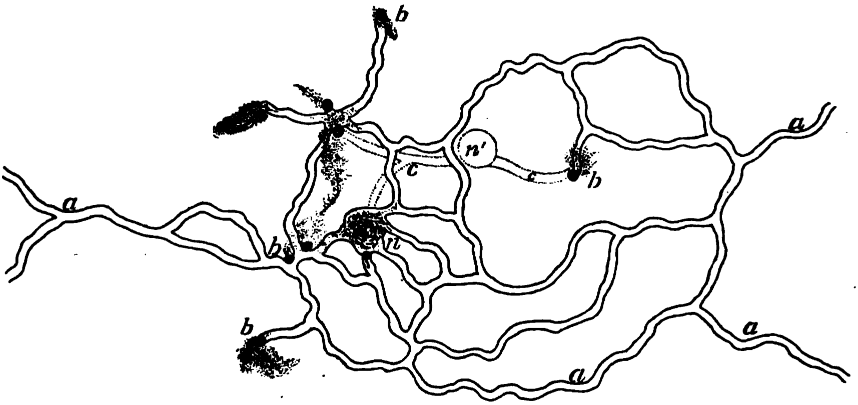

FIG. 1.—Nests, burrows, and trails of *Microtus pennsylvanicus*. *a*, Surface trails; *b*. opening to burrows; *c*, underground tunnels; *n*, surface nest; *n'*, underground nest.

The rapidity with which meadow mice work is surprising. If the nest is destroyed they choose a new site and construct a new nest of fresh materials in a single night. They work both night and day, but are especially active in the evening and early morning. They are less active in the middle of the day, especially in sunlight.

When disturbed in their homes meadow mice rush about with great celerity; but in sunlight especially they do not see well, and are almost as liable to rush blindly toward the point of danger as away from it. When cornered, they stand on their haunches and defend themselves

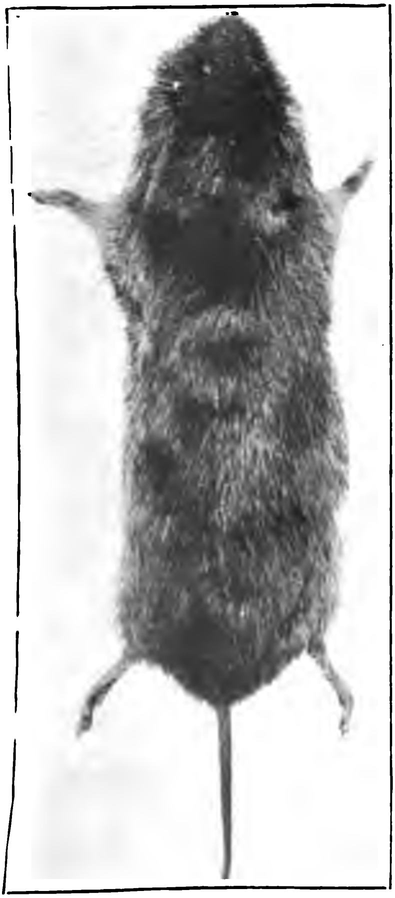

FIG. 1.—MEADOW MOUSE (MICROTUS PENNSYLVANICUS).

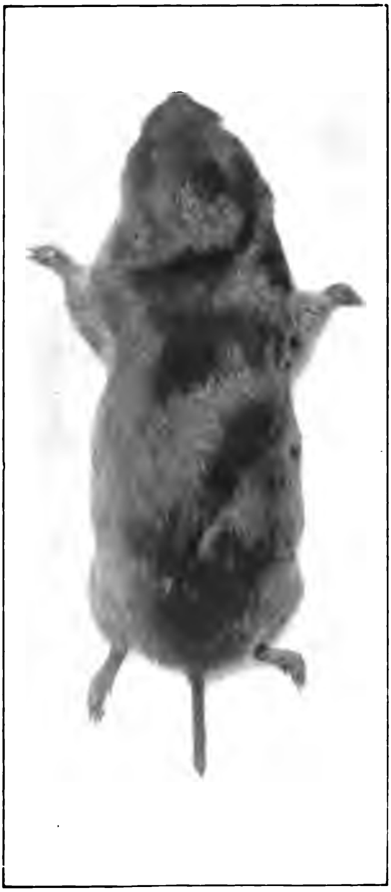

FIG. 2.—PINE MOUSE (MICROTUS PINETORUM SCALOPSOIDES).

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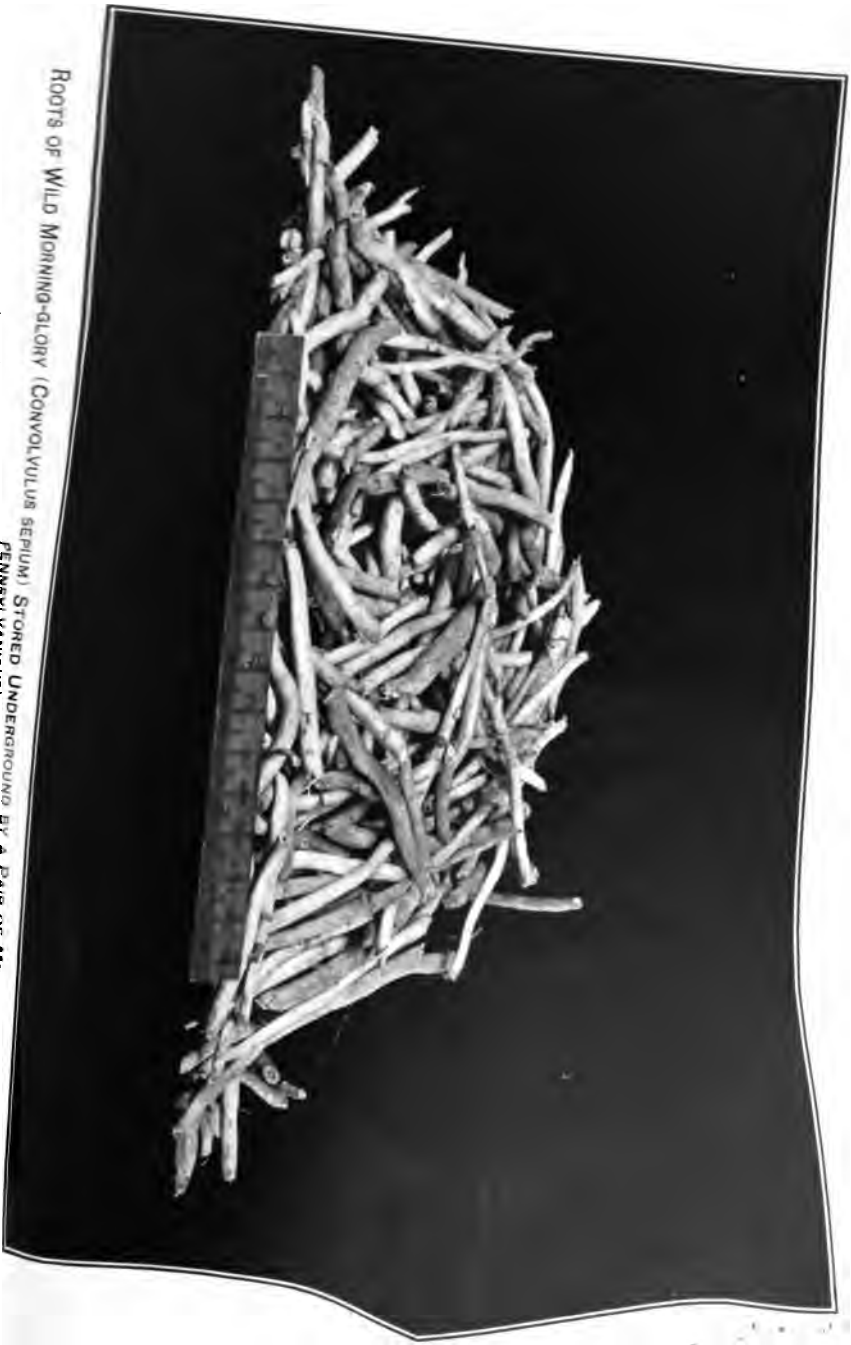

ROOTS OF WILD MORNING-GLORY (CONVOLVULUS SEPIUM) STORED UNDERGROUND BY A PAIR OF MEADOW MICE (MICROTUS PENNSYLVANICUS).

[Weight of roots, 18 ounces. The scale in the illustration is 6 inches long.]

M10U

with great valor, and their sharp teeth are rather formidable weapons. Sometimes after capture one seems to give way to uncontrollable anger, and when placed in a cage with others of the same species it is eager to attack all its fellows. When two engage in combat they stand up on the hind feet and fight with claws and teeth, keeping up a constant squeaking.

Meadow mice soon adapt themselves to confinement. They eat almost any food offered and soon become tame. I find, however, that certain succulent roots, particularly those of the wild white morning-glory (*Convolvulus sepium*), are preferred to everything else. This root tastes much like sweet potato and is abundant in swamps and waste places frequented by the mice. While feeding they sit up on their hind legs and use the front paws to handle the roots, after the manner of squirrels.

This species often stores up food in underground galleries. I have several times discovered such hoards, consisting of leaves or succulent stems, but more frequently entirely of the morning-glory roots already spoken of. On March 5, 1907, I collected the contents of such a cache, which weighed 18 ounces (Pl. II).

The species under consideration never lives in barns or outbuildings. Its nearest approach to human habitations is the stackyard or piles of wood or boards left on the edge of orchards or fields near houses. In the far north a closely related species, the Drummond vole (*M. drummondi*), enters houses and barns much after the manner of the common house mouse.

The common meadow mouse is especially noted for long winter excursions from its summer abode, hiding its movements under cover of deep snow. The journeys of the animals are not suspected until the snow disappears, when the trails can be traced to great distances. They reach wheat, rye, clover, and timothy fields and often extend into orchards, nurseries, lawns, and gardens, all of which are injured by the animals. Haystacks or shocks of corn and other grain are sure to suffer if left out over winter.

The Old World species of field mice most noted for extensive ravages of crops, and including such well-known forms as *M. agrestis*, *M. arvalis*, and *M. hartingi*, are very closely related to our common meadow mouse. Many of the more prominent American species, as the Drummond vole (*M. drummondi*), the Peale vole (*M. montanus*), the dwarf vole (*M. nanus*), the Townsend vole (*M. townsendi*), and the California vole (*M. californicus*), belong to the same group. Their wide distribution brings meadow mice into contact with agriculture over great areas, and this fact, added to their prolific breeding, renders the group the most destructive one in the genus under consideration. As farming is pushed northward in the British provinces and as the cultivated areas in the West are extended under the stimulus of the United States Reclamation Service, the danger of serious ravages by meadow mice will increase rather than diminish.

II. THE PRAIRIE MOUSE.

Microtus ochrogaster Wagner.

The prairie mouse is probably second only to the common meadow mouse in the extent of its injury to crops. Outwardly it differs but slightly from the latter species. Its tail is shorter (less than twice the length of the hind foot) and its fur is coarser. In winter the pelage is grayer. The color of the underparts shades into a buff or cinnamon. The contrast between the upper and lower parts of the tail is much sharper than in the common meadow mouse. The foot pads are 5, and the number of mammæ 6 (2 pectoral and 4 inguinal). Its average measurements are about as follows: Length, 155 mm. (6 inches); tail vertebræ, 38 mm. (1.5 inches); hind foot, 21 mm. (0.82 inch).

The prairie mouse occurs in southern Wisconsin, in Indiana, Illinois, Iowa, Missouri, Nebraska, Kansas, and a part of Oklahoma. It lives in the open prairie country, mainly in the Upper Austral zone. Thus it is much more likely to invade crops than if its natural habitat were in swamps. I have found it on the borders of corn and cane fields and in native meadows, as well as in cultivated clover and alfalfa fields. It seems especially partial to fields that have been allowed to lie fallow for several seasons. The soft mixed annual grasses and weeds that partly replace the original prairie cover seem to furnish it congenial surroundings. Close grazing of the open ranges tends to drive out voles, but when ranges are not closely pastured, so that an abundance of old grass is left, prairie mice soon become numerous and appreciably reduce the amount of forage.

In the same manner the prairie mouse invades pastures and neglected orchards whenever dry grass is permitted to accumulate and remain over winter. If no crops are near, the animals subsist on wild herbage, roots, and seeds; but when cultivated crops are accessible their trails soon extend far into the tilled fields.

Nests of prairie mice usually are less bulky than those of the common meadow mouse, but are built in a similar way and in like situations. The number of young at a birth is usually three or four, rarely five or six. In ordinary seasons the first litter is born in April, but in dry, warm springs the time may be fully a month earlier. The number of litters in a season varies with climatic and other conditions. On the whole, prairie mice multiply less rapidly than meadow mice, since the number of young at a birth is smaller, and the long summer droughts and extreme winters of the interior prairies of the West often limit reproduction.

Robert Kennicott's excellent account of this species[a] states that in confinement the animals were practically omnivorous, rejecting but little vegetable food offered them. The amount of food consumed was astonishingly great. Three ate in twenty-four hours, besides other food, the germs from all the kernels of a large ear of corn. They ate raw fresh meat and drank much water.

My own observations of the prairie mouse confirm published accounts. Near alfalfa fields in Kansas I found that the green leaves of this forage plant were the favorite food. This was made evident by the trails leading to the fields and by careful stomach examinations of individuals captured.

In winter the prairie vole sometimes does enormous damage to fruit trees. In this respect it is, if possible, more destructive than the common meadow mouse; and as the fruit industry in the West grows in magnitude this species is likely to become still more troublesome. In Kansas and Missouri, during the winter of 1903-4, many orchards and nurseries were severely injured by the prairie mouse, and during the two following winters the losses were greater rather than less.

This species comes into contact with agriculture in the major portion of eight States lying in the humid section of the central Mississippi Valley. These eight States produce annually more than half the corn, oats, and winter wheat, and more than a third of the hay of the entire United States. Two closely related species of prairie mice (*M. haydeni* and *M. minor*) extend the range of this group on the plains to the west and northwest. Here they are abundant in sections where barley and spring wheat are important crops. The possibility of serious crop damages from prairie voles is, therefore, especially great.

III. THE PINE MOUSE.

Microtus pinetorum scalopsoides (Aud. & Bach.). (Plate I, fig. 2.)

This pine mouse, called also the mole-like vole, has a wider distribution than the typical southern pine mouse (*M. pinetorum*), and therefore is chosen as the representative of the group. The following account of its habits applies equally well to all pine mice.

This animal has the wide, flat skull, the short tail, the small ears, and the short, dense, glossy brown fur characteristic of all the pine mice. The colors, however, are less glossy and the size somewhat larger than in typical *M. pinetorum*. The claws are well developed; foot pads 5; mammæ 4 (2 pairs of inguinal). The average measurements of three New York specimens, as given by Bailey, are as follows: Total length, 125 mm. (about 5 inches); tail vertebræ, 20 mm. (0.78 inch); hind feet, 16.3 mm. (0.64 inch).[a]

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[a] The Quadrupeds of Illinois Injurious and Beneficial to the Farmer. Patent Office Report: Agriculture, 1856, pp. 97-102, 1857.

Owing to their peculiar habits, pine mice are not so well known as are meadow mice. Their natural habitat is the forest, although they are by no means restricted to pine woods or forested areas. While often inhabiting pine woods and the edges of adjacent fields, they live also in forests and copses of deciduous trees, usually on uplands.

The life of pine mice is largely spent in underground tunnels, which so closely resemble those of the mole that generally they are mistaken for the work of that animal. The ridges of loose soil over the tunnel are exactly like those thrown up by the mole, but the inner diameter of mouse tunnels is less. When moles and pine mice live in the same vicinity, the mice often use the runways made by the moles. It is this habit that has helped to bring moles into disrepute with farmers, who blame them for damages inflicted upon potatoes and other crops by pine mice.

In marked contrast with the pine mouse, the mole (genus *Scalopus*) is almost exclusively carnivorous, eating mainly earthworms and insects. While it sometimes cuts off the roots of growing plants when they interfere with its tunneling operations, it apparently eats no roots. Stomach examinations of moles show that they eat a very small percentage of vegetable matter, and this mainly waste corn or other grain previously softened by long contact with wet soil. On the other hand, pine mice eat little insect food, if any, and are largely consumers of vegetable substances. Nearly always when moles are charged with destroying root crops, the real culprits are pine mice.

Thin, open woodlands used for pasture, and thickets along the edges of forests are favorite resorts of pine mice. Like nearly all voles, they prefer moist soil, but it must also be loose and somewhat sandy. From their intricate tunnels under the leaf mold frequent burrows descend into the soil. Some of these burrows are utilized as nesting places. Nests are built also at the surface of the ground, under fallen logs, brush heaps, flat stones, fences, or other shelter.

The number of young at a birth evidently averages less than is usual in the genus *Microtus*, as is shown by the small number of mammæ. Observations as to the number of litters in a season seem to be lacking, but the rate of reproduction is probably less in the pine mice than in any other American group of field mice. Blasius says concerning *M. subterraneus* of Europe, that "it produces five or six times a year three to five young, which are blind for ten days after birth;"[b] and this statement is probably true, with slight modification, for all the species of the group. To compensate for slower multiplication, their liability to attack by natural enemies is much less, owing to their underground existence; so that within their range pine mice are about as abundant as other field mice.

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[a] N. A. Fauna No. 17, p. 64, 1900.

[b] Naturgeschichte der Säugethiere Deutschlands, p. 390, 1857.

Quick and Butler, writing of the food habits of the pine mouse in Indiana, state that it lives upon the tender roots of young hickories, the young sprouts of white clover, the fruit of the red haw, and the tuberous roots of the wild violet (*Viola cucullata*). The writers found all but the fruit buried, some in deposits of a gallon in a burrow, and the caches sometimes extending 18 inches below the surface of the ground. Violet roots predominated in these stores.[a] Kennicott also states that pine mice store acorns and nuts in burrows for winter use. Blasius and Brehm both state that the European species (*M. subterraneus*) prepares such stores. While personally I have never found such deposits, it is probable that our species have this habit to an extent greater than is generally known.

From their homes in woods and thickets pine mice invade fields, orchards, nurseries, dooryards, and gardens, passing always through underground runways. Living in concealment, neither their presence nor the injury they inflict is suspected until the latter is past remedy. Bulbs, planted hopefully in autumn, appear not at all in spring, or only in the shape of sickly plants whose life substance has been gnawed away. Nursery and orchard trees here and there put forth no leaves, and an examination of the roots discloses the nature of the damage.

Potatoes, sweet potatoes, carrots, beets, and other vegetables are eaten by pine mice, both while growing and when stored in pits or lying in piles in the field or garden. Potatoes partly matured or left long in the ground after maturity are eaten, and the injury is attributed to moles, because tunnels supposed to be the work of moles lead to the place of damage. I have investigated numerous cases of such injury and have invariably found either that the tunnels were made by pine mice, or, if mole tunnels, that they were frequented by mice. Traps set in the tunnels at the potato hills captured pine mice, and the starchy material found in the stomachs of those caught proved that they, and not moles, had been eating the potatoes.

Pine mice occur in central and southern Europe, in the eastern United States, and in a limited part of eastern Mexico. Those in the United States occur chiefly in the Upper Austral zone. The typical species (*M. pinetorum*), with bright russet-brown color and glossy mole-like fur, is found only in parts of Georgia, South Carolina, and southern North Carolina. In the last-named State it grades into the subspecies *scalopsoides*, which is much more widely distributed, ranging northward to southern New York (Hudson Valley and Long Island) and westward to Illinois. West of the Allegheny Mountains it occurs mainly north of the Ohio River, except in West Virginia.

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[a] American Naturalist, vol. 19, p. 116, 1885.

The bluegrass vole (*M. p. auricularis*), a form with ears overtopping the fur, which is dark and glossy, occurs in southern Indiana and in Kentucky, Tennessee, Mississippi, and Alabama. It has been taken in northeast Texas also, so that its range probably extends through southern Arkansas and connects the two areas.

The woodland vole (*M. p. nemoralis*) is the largest form of the pine vole in America, and has longer and less glossy fur than the forms east of the Mississippi. Its color is deep chestnut, darker than typical *pinetorum*, but lighter than *scalopsoides* or *auricularis*. It occurs in wooded parts of southern Iowa, eastern Nebraska and Kansas, and in Missouri, northern Oklahoma, and Indian Territory.

Pine mice differ greatly in habits from the other species of *Microtus*. All the American representatives of the group have similar habits, and the injury they do to crops is little less in extent than that inflicted by meadow mice and prairie mice.

DAMAGE BY FIELD MICE.

While field mice of the various groups differ but little in the nature of their food, the circumstances under which they injure crops vary. Meadow mice invade cleanly cultivated fields only under the shelter of snow. Hence they do most damage in years of great snowfall. Although prairie mice commit greater depredations under cover of snow than in open seasons, their attacks upon crops are far less dependent upon snowfall than those of meadow mice. Pine mice work in the shelter of their own burrows; hence their injuries to plants are quite independent of the amount of snow.

DAMAGE TO MEADOWS AND PASTURES.

Complaints of damage to meadows and pastures by field mice have been increasing in recent years. Usually the injury is confined to small areas, which the animals attack from the shelter of snowdrifts or old grass. Under cover of these, the animals eat the succulent crowns of clover and other grasses; and when the snow lies for several weeks the crops over large areas are often completely ruined. Sometimes whole fields of red clover are so badly damaged by mice that they have to be replowed in the spring and planted to other crops.

Damage to permanent, or uncultivated, meadows is usually more serious, as the mice breed and multiply throughout the field and, under cover of the growing crop of leafy stubble, devour and destroy throughout the year. Occasionally, however, actual benefit may result from their thinning the grasses and stirring the soil about the roots. Thus, after the vole plague in Scotland in 1892, the farmers reported that the pastures were better than before; but the improvement by no means compensated for the losses caused by the impaired pasturage of the two preceding years.

When mice are abundant during the growing season, the quantity of grass they destroy is great, more being cut down and left upon the ground than is actually consumed. In winter hay in stacks is injured by field mice, and instances are known in which large stacks were so badly damaged that in the spring little or no salable hay remained.

DAMAGE TO GRAINS AND FORAGE.

Growing grains—wheat, oats, barley, rye, and buckwheat—are destroyed by field mice. Attacks begin with the sprouting grain, and, in the case of fall sown wheat and rye, continue during the entire winter. However, when only the blades of the plants are eaten this winter consumption has but little effect upon the amount of grain subsequently harvested. Much greater damage is done when the grain is nearly mature, as stalks are then cut down. After the grain ripens, devastation by mice continues until after harvest, when the animals attack the shocked grain and even the stacks. The total amount of injury by mice depends both on the number of the animals present and on the length of time the grain is left in shocks. In these artificial shelters mice are perfectly at home and multiply with great rapidity, so that within a few weeks a pair and their progeny may totally ruin an entire shock of wheat or oats.

As nearly all farmers know, field mice destroy corn, Kafir corn, and cane, whether stored in shock or in pile. The annual destruction both of grain and of forage throughout the country is enormous, although accurate statistics of losses are not available. Of course, not all the injury is done by short-tailed field mice. White-footed mice (*Peromyscus*), pocket mice (*Perognathus*), harvest mice (*Reithrodontomys*), and ordinary house mice (*Mus musculus*) also are concerned in the damage. Throughout the country the brown rat (*Mus norvegicus*) and in the Southwest the cotton rat (*Sigmodon*) are serious field pests. The several kinds of field mice, however, partly because of their wide distribution, but mainly because of their great abundance, are the chief offenders in northern fields.

Grain and forage in stacks are often injured by field mice. In view of the losses to which stacked and stored grain is subject, it is a question whether the farmer who hastens to market his crop is not, on the whole, a gainer over his neighbor who waits for more favorable prices.

DAMAGE TO GARDEN CROPS.

Field mice do much injury in market and other gardens, attacking planted seeds in the open garden, hotbed, or cold frame. Pine mice are the chief offenders in inclosures, sometimes working their way even into greenhouses, where they attack bulbs and tender growing plants, as well as all kinds of seeds.

Field mice injure early peas and other vegetables growing in open grounds, and pine mice often destroy potatoes in the ground. In the fall vegetables piled on the ground or stored in pits are liable to attacks. Among these are potatoes, beets, turnips, carrots, parsnips, cabbage, sweet potatoes, and especially celery. Apples, pears, and other fruits are eaten also.

In parts of eastern Maryland pine mice have recently (1907) been quite destructive to melon and cantaloupe crops. The animals destroy the seed and eat the roots of the plants during the growing season. The injury was greatest on sandy lands which had not been plowed before planting, but had been smoothed with a drag, leaving the mouse tunnels below undisturbed. In some fields seed had been planted three times, but by the middle of July all hope of a crop had been abandoned.

DAMAGE TO SMALL FRUITS.

Blackberries, raspberries, grapes, currants, gooseberries, and strawberries are often badly damaged by field mice, and when the animals are abundant whole plantations are ruined. Strawberries are especially liable to injury because of winter mulching and also because the plants themselves furnish excellent food and shelter for the animals.

Fallen leaves in autumn and snow in winter drift and collect along rows of blackberry, raspberry, gooseberry, and currant bushes and furnish cover for mice, which work along the rows and girdle the green stems; and when dead canes are left uncut and weeds are permitted to grow up among them, the resulting tangle adds much to the liability of attack. Winter mulching of small fruits also increases the danger, and if practiced the utmost care should be taken to clean surrounding areas.

DAMAGE TO NURSERY STOCK.

In many sections of the United States and southern Canada nursery stock is injured by field mice. The actual loss varies from year to year and is difficult to estimate. Occasionally the havoc has been so complete that few marketable trees remained. It was estimated that during the winter of 1901–2, nurserymen in the vicinity of Rochester, N. Y., sustained losses amounting to $100,000.[a]

Damage to standing nursery stock is done usually under cover of snow, and hence is greatest in seasons of deep snows that remain long upon the ground. In addition to girdling trees above the surface of the ground, meadow mice sometimes burrow beside the trunk and attack the roots (Pl. III, fig. 2). Pine mice usually begin their attacks below the surface and except under cover of snow rarely extend them above ground. They sometimes consume the entire roots of small apple trees so that only the trunk is left (Pl. III, fig. 1). Experienced nurserymen prevent serious injury to standing stock by clean cultivation. Stock that has been taken up in the fall and " heeled in " or kept in storage pits is, however, liable to attack, especially if covered by straw, leaves, or other litter. Hence for protection from freezing a loose covering of soil is better than litter. Winter seed beds of conifers, oaks, and nut-bearing trees are often attacked by field mice and need to be carefully protected from them as well as from white-footed mice (*Peromyscus*). Small pine trees in the nursery also are liable to injury, since their low branches usually furnish cover for mice.

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[a] New York Sun, April 27, 1902.

Among the nursery stock injured by field mice are apple, pear, quince, plum, peach, cherry, crabapple, sugar and Norway maple, chestnut, black locust, Osage orange, sassafras, alder, white ash, mountain ash, various oaks, cottonwood, willow, pine, and wild cherry trees; also blackberry, raspberry, rose, currant, and barberry bushes, as well as grape vines. In the Arnold Arboretum, Jamaica Plain, Mass., during the winter of 1903–4, meadow mice destroyed thousands of trees and shrubs, including apple, maple, sumac, barberry, buckthorn, dwarf cherry, snowball, bush honeysuckle, juniper, blueberry, dogwood, beech, and larch. Plants in nursery beds and acorns and cuttings in boxes especially were harmed.[a]

INJURY TO ORCHARDS.

Trees transplanted from the nursery into the orchard are in more danger from field mice while the outer bark is green and tender, but there are instances in which trees 5 and 6 inches in diameter have been attacked and killed by them. Most farmers are inexperienced as orchardists, and plant fruit trees only for family use. Engrossed in the production of other crops, they often neglect the orchard and permit annual grasses or weeds to grow up, which afford cover for mice. Often, too, clover or orchard grass is sown in the orchard as a covering for the ground, and the heavy growth left for winter mulch is augmented by fallen leaves. Under such conditions it is not strange that mice injure the trees. It is remarkable, indeed, that so many orchards escape injury. That they do so may in part be attributed to the fact that they are often near dwellings, where hens scratch and cats prowl.

Attacks upon orchards by mice are not always accomplished under cover of snow, nor are they confined to winter. They frequently occur in summer, often in September. During the winter of 1905–6 a small orchard of apple and pear trees near Washington, D. C., was under observation from October to April. Attacks by meadow mice began in the early fall, possibly in August. They were continued during every succeeding month, being greatest during two short periods of snow. Independent of snowfall, they were greatest in mild and least in cold weather. A few trees had no weeds or grass near the trunks, and these escaped injury. The neglected condition of this orchard appears from a photograph (Pl. IV) taken January 24, 1906. Adjoining the orchard was a tangled thicket on low, moist ground, in which meadow mice were abundant.

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[a] Boston Transcript, April 16, 1904.

On March 16, 1906, I found that of 380 apple trees, 164, or over 43 percent, were ruined, being completely girdled, some to a height of 8 to 10 inches above the ground. Thirty-six others, nearly 10 percent, were less badly injured, while 180, or 47 percent, apparently, were uninjured.[a]

Of 200 pear trees in the orchard 50 were more or less seriously damaged. The injury to these was inflicted early in the fall.

The nature of the damage to individual trees in the orchard is well shown in Plate V.

INJURY TO FOREST TREES.

As an example of the danger from field mice to which plantations of forest trees are exposed, the following is cited: In 1813 and 1814 young plantations of trees in Dean and New forests, England, were greatly damaged by mice, probably *M. agrestis*. The damage was to planted acorns, two-thirds of which were destroyed, and to holly, oak, and chestnut trees, some of which were 5 years old. Not only were the trees girdled above the surface of the ground, but often the roots also were gnawed through. The land was covered with long grass, ferns, etc., which furnished abundant shelter for voles.[b] During the winter of 1813–14 more than 30,000 mice by actual count were destroyed in Dean Forest and 11,500 in New Forest. It was calculated that the total killed by all the agencies employed was probably double these numbers. The total number of voles killed in both forests during the outbreak was estimated at 200,000.[c]

In the past, American forestry has concerned itself chiefly with efforts at conservation, but forest extension has progressed far enough to enable us to judge of the extent of injury that field mice are likely to inflict upon new plantations. The experience in the Arnold Arboretum, already referred to, is probably an example of what may be expected.

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[a] On June 22, 1907, the number of apple trees alive in this orchard was 226. The dead trees numbered 154, many of which had succumbed to their injuries during the spring of 1907. The trees were thoroughly sprayed with lime-and-sulphur wash in November, 1906, and although many meadow mice and some rabbits were present, none of the trees were attacked during the succeeding winter.

[b] Lord Glenbervie's Account, Zool. Journ., vol. I, pp. 433–444, January, 1825.

[c] Bell's History of British Quadrupeds, p. 325, 1874.

Dr. C. A. Schenck, forester of the Vanderbilt estate, Biltmore, N. C., in a recent communication to the Biological Survey, states that plantations of locust and black cherry suffer badly from the girdling of mice, "especially the locust, which are killed outright, usually the best specimens." And he adds, "Plantations of acorns, chestnuts, and hickory nuts are rendered impossible because of ravages of mice."

In our native forests the injury to young trees by mice has usually been unnoticed or disregarded; but hereafter, as more attention is given to forest extension, a corresponding increase in interest in mice as enemies of forest trees may be expected.

DAMAGE TO PARKS AND LAWNS.

Field mice destroy bulbs, perennial herbaceous plants, woody shrubs, and ornamental vines. To name all the kinds subject to attack is unnecessary, as but few are immune. The animals invade botanic gardens and public parks as well as private grounds. In the public parks of Hartford, Conn., during the winters of 1904 and 1905 much damage was done, especially to common laurel (*Kalmia latifolia*) and various thorns (*Cratægus*). Rosebushes and the crowns of hollyhocks are often attacked. Pine mice usually are responsible for the injury to bulbs—tulips, hyacinths, crocuses, etc. Often the straw or other litter used to protect tender plants furnishes shelter for the animals. Hedges, while often subject to injury from voles, also afford protection under which the animals gain access to ornamental plantations.

During the winter of 1904–5 pine mice invaded dooryards near Lanham, Md., and destroyed many plants. In one case 50 choice hyacinths and tulip bulbs in a bed were badly eaten, so that only 4 or 5 sickly plants came up in spring. In an adjoining dooryard, in the spring of 1907, the animals girdled a considerable number of young white pines (*Pinus strobus*) and ate the roots.

STUDIES IN AN ORCHARD.

In December, 1903, I examined a large orchard in Marion County, Kans., where field mice were causing much damage. As the case of this orchard is in many respects typical, details of its treatment will be given. The orchard comprised 480 acres and contained about 26,000 trees, mostly apple, eight to ten years transplanted. The trees averaged about 4 inches in diameter, but many measured 5 or 6 inches. The majority were headed low, their outer drooping branches touching the ground (Pl. VI, fig. 1). In the spring of 1903 corn had been planted by listing it in the open spaces between the rows of trees; but owing to an unusually wet summer, the crop had been abandoned, and sunflowers and other weeds and grasses had made a luxuriant growth throughout the orchard. Over much of the area, apparently, no attempt had been made to cut down the weeds: and where they had been mowed they had been raked into piles and not burned or removed.

In this neglected orchard field mice—the prairie vole—had found a congenial home. Already abundant in 1902, they bred plentifully in the open fall of that year and in the early warm spring of 1903. The ensuing moist summer also was favorable for continued reproduction, and by the fall of 1903 they were present in hordes. All the orchards of the neighborhood—a comparatively level upland prairie—had been neglected and all were invaded by mice; but the one above mentioned was the largest and most neglected, and therefore it suffered most severely. By December 18, the date of my first visit, mice had wholly or partially girdled at the surface of the ground fully 5,000 apple trees and had denuded of bark many of the low branches. The owners of the orchard, thinking that none of the trees could survive the injuries, then estimated their loss at from $25,000 to $30,000.

Examination showed that the ground everywhere was honeycombed by mouse burrows and tunnels to a depth of 3 or 4 inches, and that the surface was almost covered by a network of runways of the prairie vole. Upon digging into the burrows at the base of apple trees I found many twigs, 4 to 6 inches long, that had been entirely stripped of bark and left lying in little piles. I had no difficulty in finding where the twigs had been severed from low-growing branches and the tips of sprouts, and in distinguishing, by the smaller tooth marks, the cutting done by mice from that done by rabbits. Whether the twigs had been first stored and afterwards fed upon in cold weather I was unable to determine, for I found none with bark remaining upon them. Probably they were carried to the burrows merely for leisurely but immediate consumption.

Contrary to the usual habits of voles in our Northern States, this injury had been done during mild weather. Up to December 18 the season had been warm and open. No snow lay on the ground for more than twenty-four hours. Ordinary food, such as grass, seeds, and grain, was abundant, so that the only explanation for the injury to trees seems to be the vast numbers of voles present and their preference for a partial diet of bark.

Voles, however, were not the only animals abundant in the orchard. Rabbits, both cottontails and jacks, were there in great numbers, and

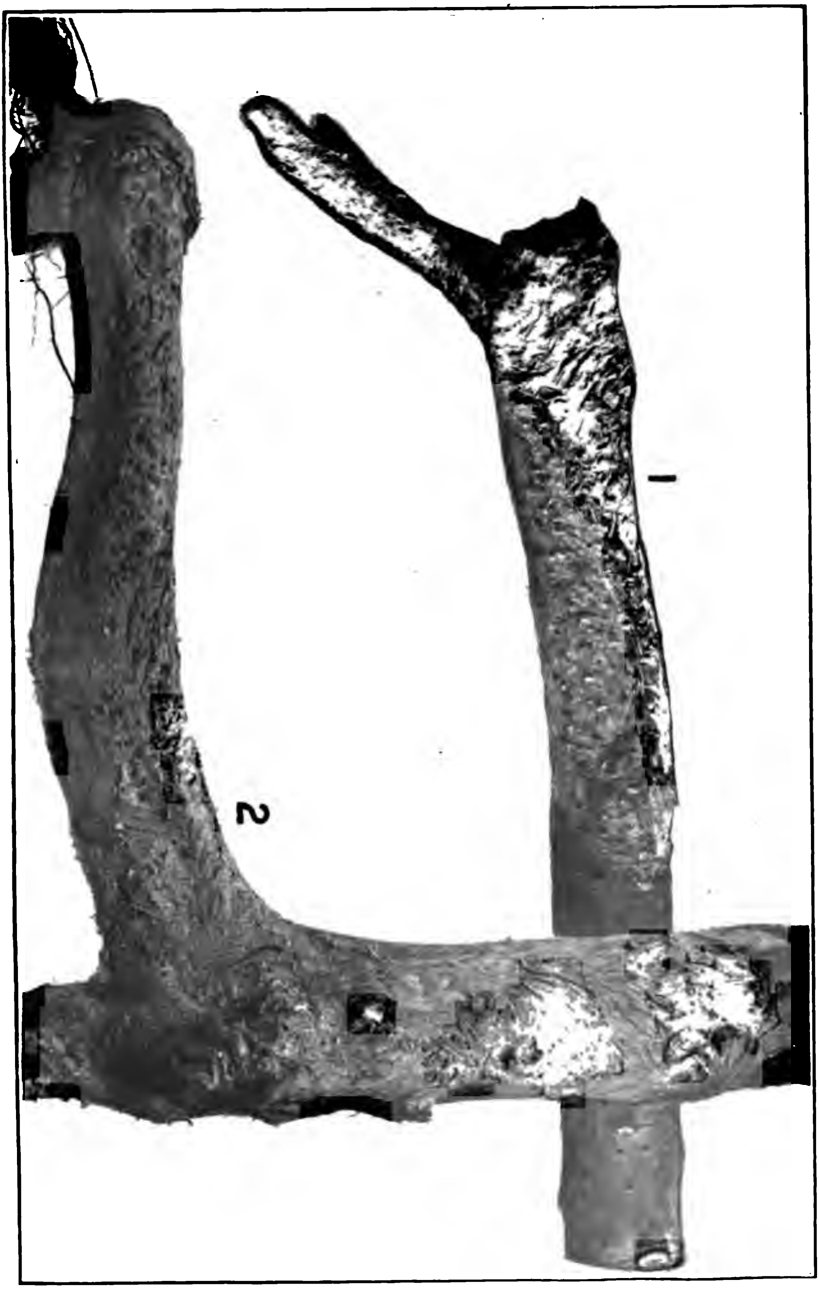
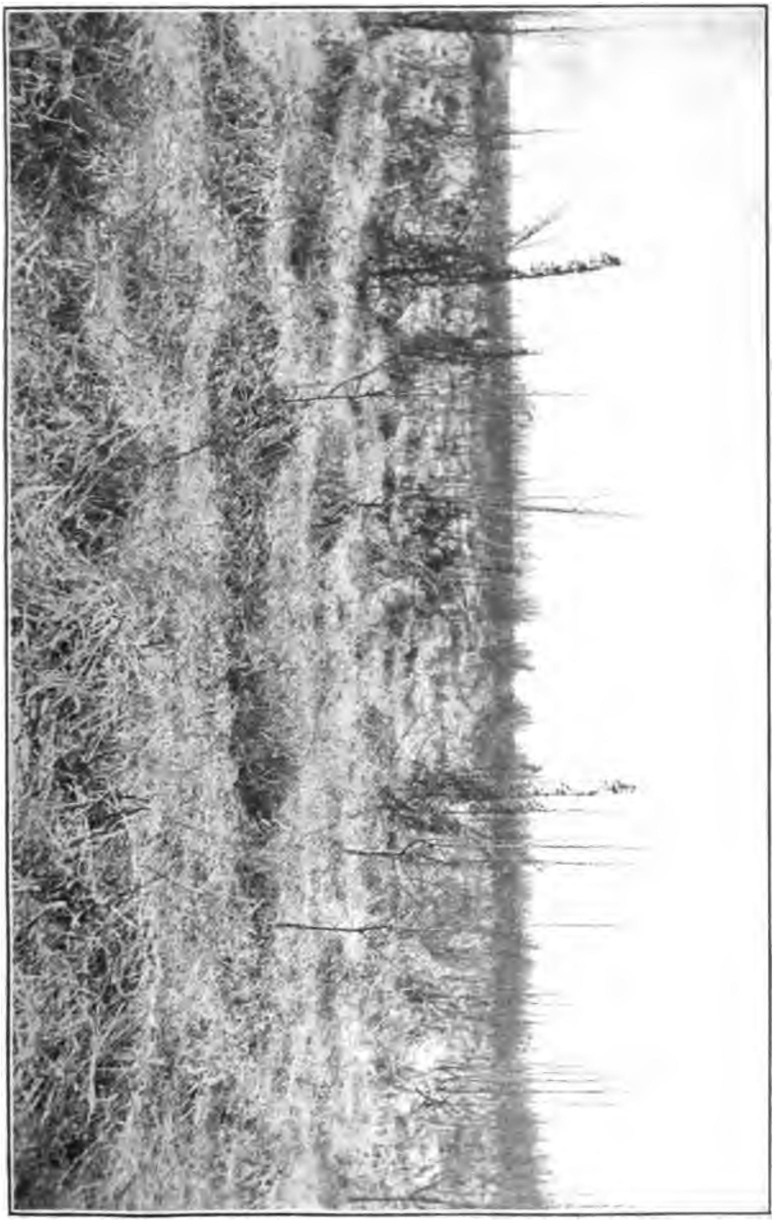


FIG. 1.—YOUNG APPLE TREE EATEN BY PINE MICE. FIG. 2.—YOUNG APPLE TREE EATEN BY MEADOW MICE.



A NEGLECTED YOUNG ORCHARD IN WINTER, WHERE MEADOW MICE RUN RIOT.

M10U

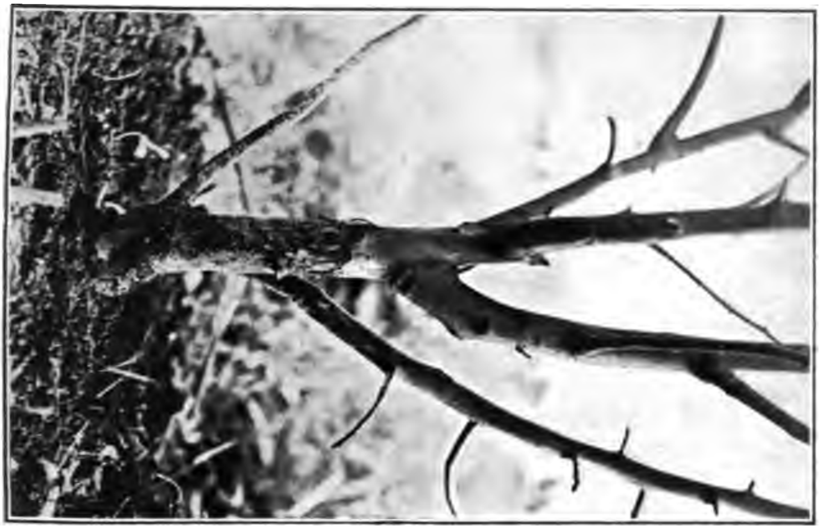


FIG. 1.—PEAR TREE INJURED BY MEADOW MICE.

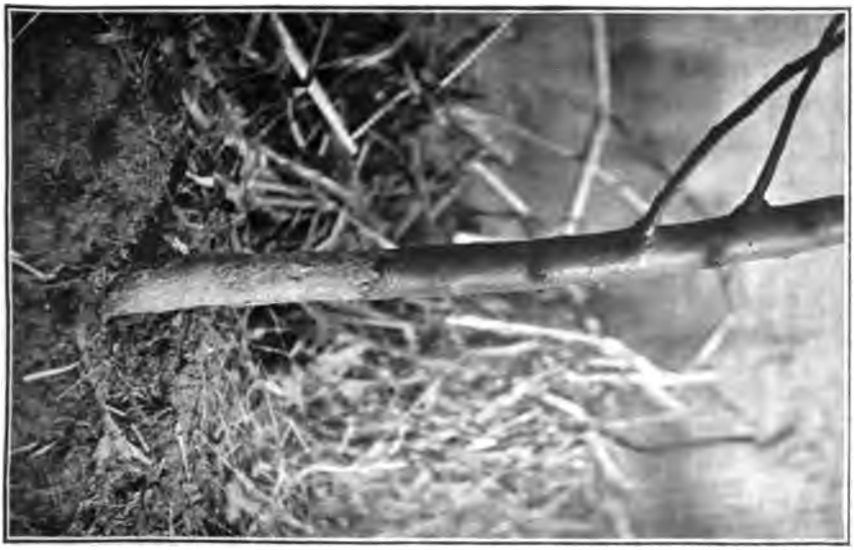


FIG. 2.—APPLE TREE INJURED BY MEADOW MICE.

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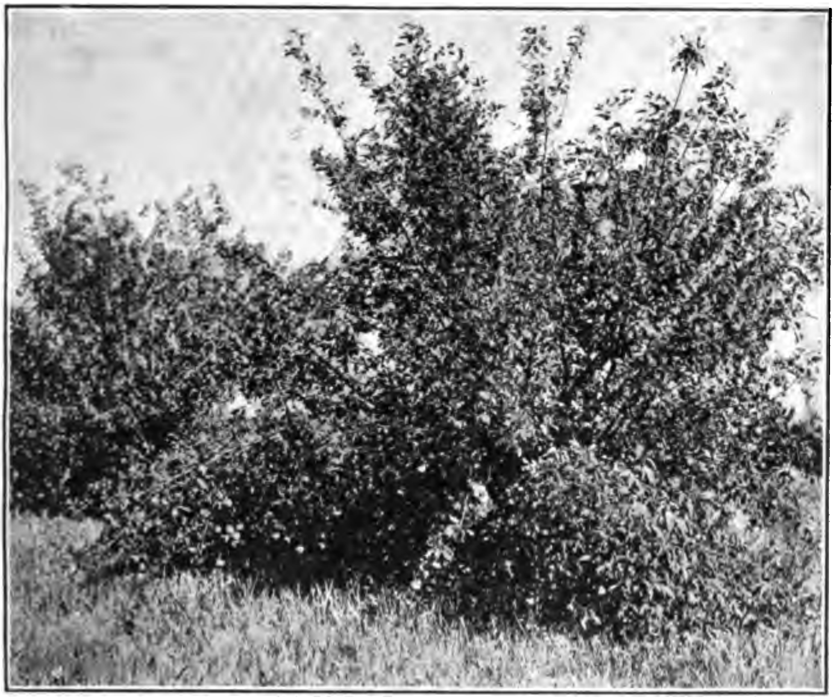

FIG. 1.—LOW-HEADED APPLE TREE IN A KANSAS ORCHARD.

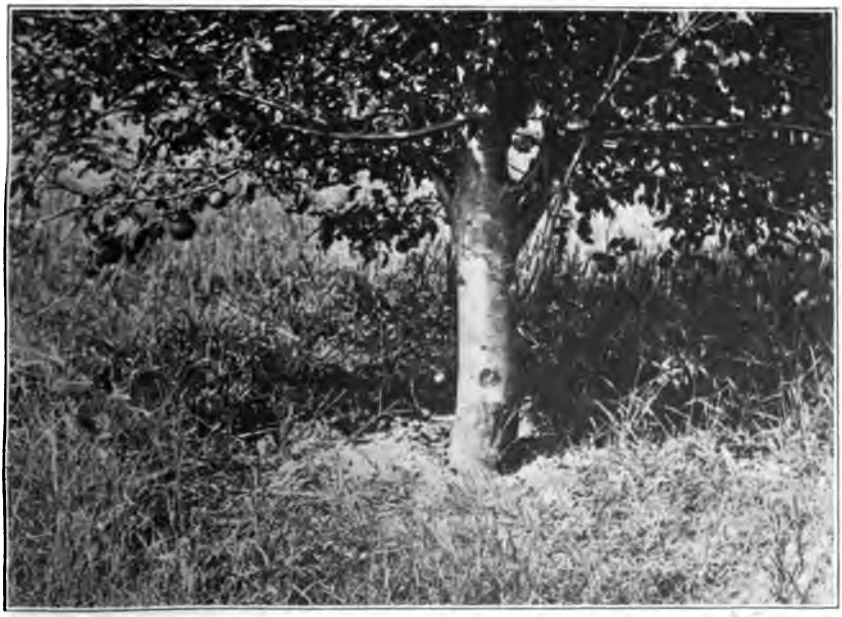

FIG. 2.—APPLE TREE RECOVERED AFTER INJURY BY MICE.

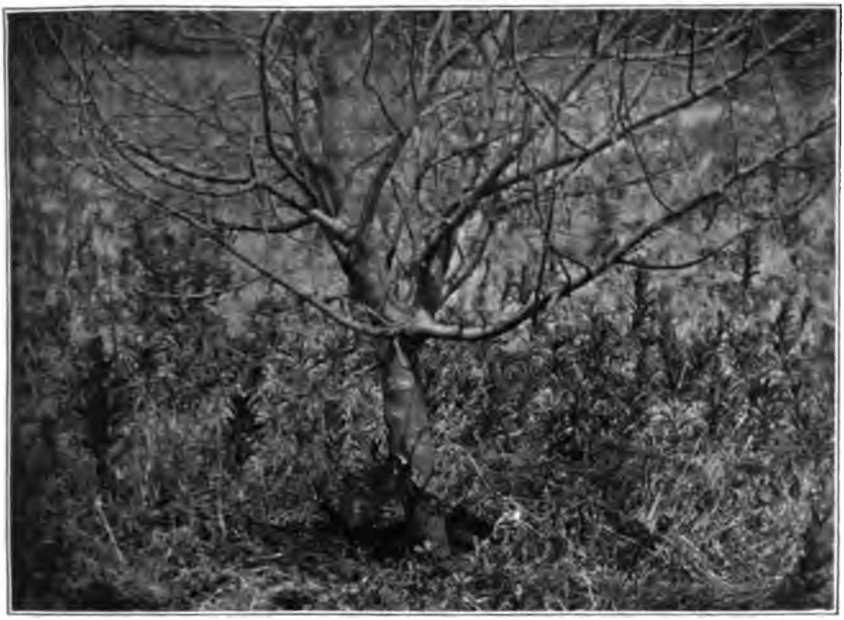

FIG. 1.—APPLE TREE KILLED BY PRAIRIE MICE.

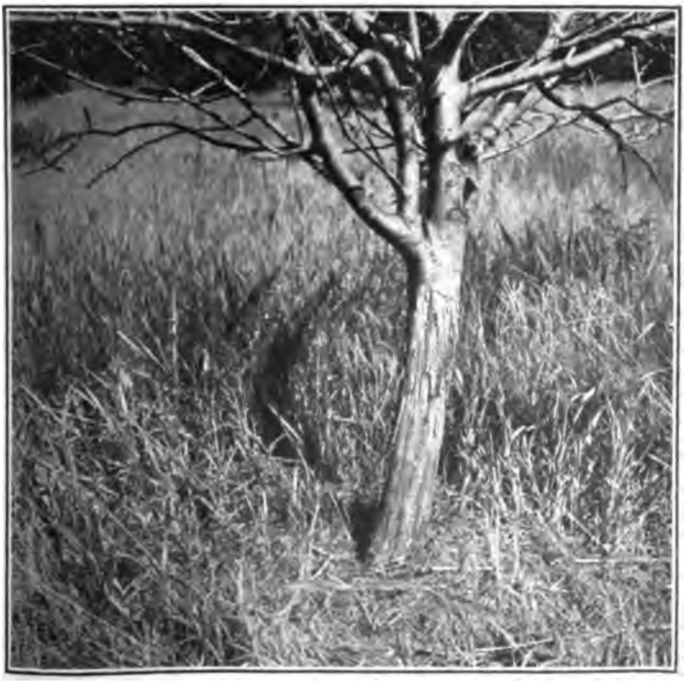

FIG. 2.—APPLE TREE KILLED BY RABBITS.

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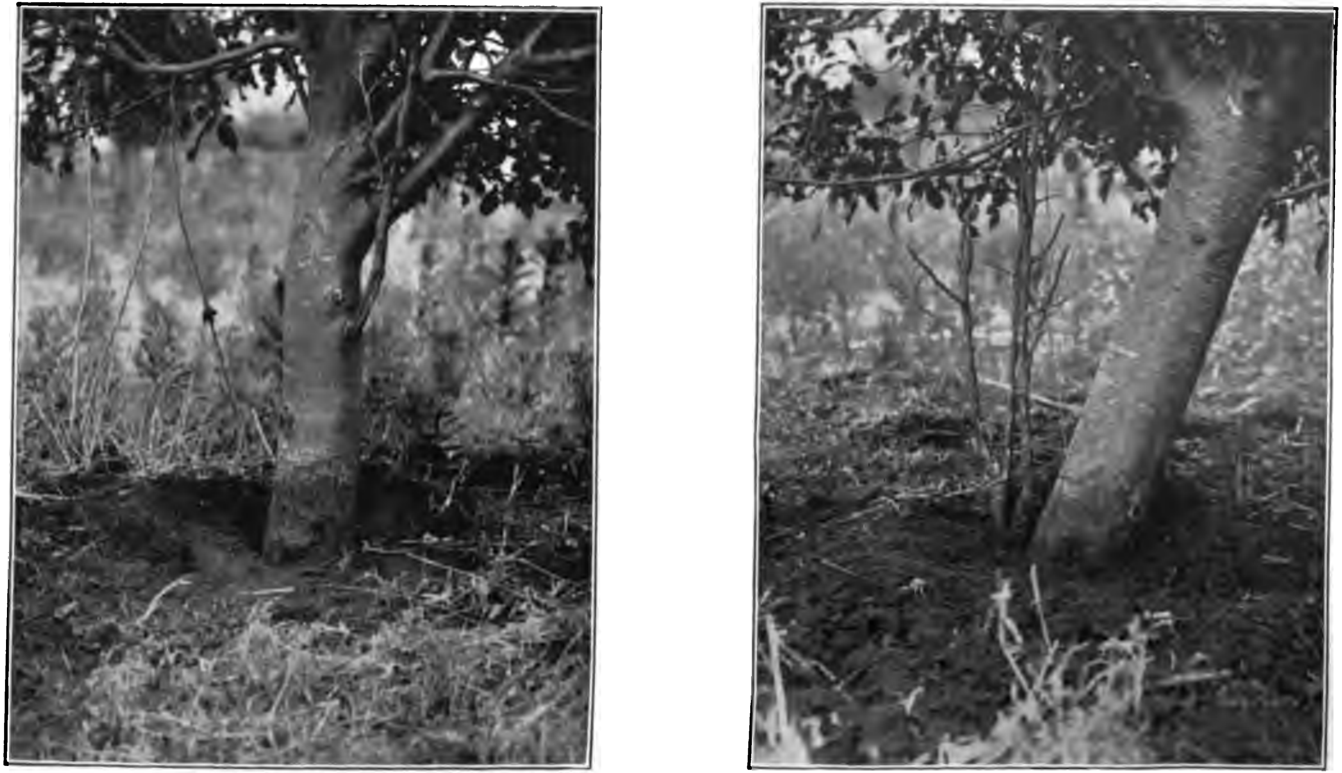

APPLE TREES 5 INCHES IN DIAMETER, GIRDLED BY PRAIRIE MICE (MICROTUS OCHROGASTER).

[Trees saved by heaping up soil about the trunks to cover the injury.]

already had begun to eat the bark on the trunks of some of the trees and on the low limbs, and to cut the tips of branches and sprouts within their reach. Later, when cold weather set in and snow covered the ground, they also seriously damaged the trees.

White-footed mice (*Peromyscus michiganensis*) were especially numerous, but stomach examinations of individuals captured revealed no evidence that they had eaten bark of trees. Skunks, short-eared owls, and marsh hawks were common, no doubt attracted to the vicinity by the abundance of mice. From the large number of partly devoured dead mice found in the burrows during poisoning operations, I had reason to think that shrews (*Blarina brevicauda*) also were abundant. Of course living voles helped to devour the dead.

Previous to my visit a force of men and boys had been employed in painting the trunks of the trees with a wash composed of soap, crude carbolic acid, and water. The efficacy of this wash as a preventive of attacks of mice or rabbits did not extend beyond a period of forty-eight hours.

On the evening of my arrival I placed wheat poisoned with strychnine at the base of about 50 apple trees. On the next morning a large number of dead voles and white-footed mice were found. So favorably were the owners of the orchard impressed by the result that a force of men was employed to distribute poisoned grain throughout the orchard.

The poisoning operations in this orchard occupied several weeks, and by January, 1904, the mice apparently had been exterminated. Rabbits, however, continued to give trouble, and the campaign against them was continued for some time longer, with final success.

As a treatment for the trees injured by mice, I recommended the immediate covering of the wounds by mounds of soil heaped up around the trunks. The plan was adopted with highly satisfactory results. New bark grew wherever the cambium layer was not eaten completely through, and a great majority of the trees recovered. (Pl. VI, fig. 2.) Had their trunks been left exposed to the sun and winds of spring and summer most of them would have died. The number of trees actually killed by mice was not very great, although the growth of many was seriously checked.

Although at first the damages from mice seemed far more extensive than those from rabbits, the ultimate losses from them probably were less. The wounds from rabbits were too high up to be successfully covered with soil, and no remedy other than wrapping with paper was tried. The difference in the character of the injuries by these animals is well illustrated by Plate VII, which shows two dead trees—one killed by mice and the other by rabbits. Plate VIII and Plate VI, figure 2, illustrate injured trees in the same orchard which have fully recovered.

The following winter, 1904–5, mice and rabbits were again abundant in the orchard, having come in from adjacent territory. The experiences of the preceding winter were repeated, except that cover for mice was less dense and the campaign against them began much earlier in the season.

During the two winters named, many other orchards throughout eastern Kansas were seriously injured by field mice. As a rule no preventive measures were used, and the total losses were enormous.

THE RELATION OF FIELD MICE TO THE FARMER.

In 1886 the Biological Survey sent out a circular letter of inquiry about damages to crops by mammals.[a] A great many replies from widely scattered places were received. The replies relating to field mice show that these animals everywhere are regarded as a pest.

The following extracts from letters on file in the office of the Bureau of Biological Survey are here presented to show not only how great is the amount of injury from field mice in certain localities, but to give an idea of the wide area over which losses are sustained.

REPORTS FROM FARMERS AND OTHERS.

Field mice are very injurious to clover fields. The injury is done by eating the roots when the ground is covered with snow. The loss is serious. They are injurious to fruit trees and yellow locust and Osage orange. They girdle them beneath the surface of the ground during deep snows. They destroy apple and pear trees, but rarely hurt peach and cherry.

—Gap, Lancaster County, Pa., Nov., 1886.

Field mice injure pastures and meadows by burrowing under grass roots and destroying them. There were more last summer than for years, I think, owing to the destruction of their natural enemies.

—Eastbrook, Lawrence County, Pa., Feb., 1887.

Meadow mice are very destructive to grain, grapes, and trees. This fall (November, 1886) three or four years ago, the fields were swarming with them. I went out with my little boy and we killed 56 in an orchard in less than two hours. In going half a mile from the station the dog picked up 15. They ruined several hundred fine apple trees for me, some of them several inches in diameter. Many thousand trees were ruined in this country. They prefer apple to plum or peach bark. —Huron, Mich., Nov., 1886.

This has been a periodical year for their invasions and the damage has been great in many fields and meadows, particularly potato fields, which have been badly damaged where the surface was grassy. They injure to a slight extent cabbage buried in the ground. Clover fields and wheat have also been damaged. They do great injury to cornfields, eating the grain and even climbing up the stalk to the ears. All kinds of vegetables are eaten. Pastures are devastated for rods where the grass is high enough to hide the mice. Other invasions occurred in 1883 and 1888. Fruit trees are not injured except in cases where there is straw or other litter: then the trees are girdled by gnawing.

—Camp Point, Adams County, Ill., Nov., 1889.

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[a] Circular No. 3, On the Economic Relations of Mammals, 1886.

Meadow mice attack almost every tree and shrub. They girdle about everything, even rosebushes, blackberry, and raspberry bushes. I saw a willow hedge yesterday (April 8, 1889), 2 years old, with nearly every stalk girdled to 6 or 8 inches above the ground. They injure pastures and meadows and destroy root crops placed in heaps. —Rochester, Mich., Apr., 1889.

Meadow mice destroy many trees and vines. The natural enemies of these mice are as much of a nuisance as the mice themselves.
—Frankfort, Mich., 1888.

Orchards here have suffered this winter from the depredations of the meadow mouse. I presume thousands of trees have been badly gnawed in this town alone. Still the war of extermination goes on against hawks and owls.
—Hammondville, N. Y., Apr., 1887.

They eat potatoes in the ground and corn in the shock. Do considerable damage to potatoes, sweet potatoes, and peanuts. —Eubank, Ky., 1887.

Field mice destroy wheat by cutting off the stalks. Sometimes the loss is serious. They are also injurious to pastures and meadows.
—French Creek, W. Va., July, 1888.

Meadow mice sometimes injure meadows. They often do serious damage to trees and shrubs. Some seasons acres of young forest trees are barked. Maple and apple suffer the oftenest. —La Crescent, Minn., Nov., 1886.

Meadow moles (voles) are present in greater numbers than ever observed before. These voles have totally ruined a great many clover meadows, strawberry patches, and pastures that were not eaten close. They have girdled hedges until they can not live, and I noticed one place where a white ash tree, 4 inches in diameter, was stripped of bark for 6 inches above the ground. They have dug into pits containing turnips and beets and devoured them completely. They promise to be with us next season in untold millions. Their presence is the more noticeable as eighteen months ago I tried to get a single specimen to send to the Department of Agriculture for identification and could not.
—Cardington, Ohio, Feb., 1890.

Field mice injure pastures and meadows by eating off the roots during winter. We are now suffering, and have been for two years, from invasions of field mice. We suffer a material loss by having the bark gnawed from most kinds of fruit trees by them during the winter. —Gansevoort, N. Y., Feb., 1888.

Our country place in Maine is being overrun with mice, which nest in the ground and destroy all the plants by eating the roots or tops of the plants as soon as they appear. —Letter from Baltimore, Md., May 16, 1904.

The summer and winter of 1883 this county was overrun with meadow mice. They destroyed thousands of apple trees, besides lots of young forest trees. Besides girdling trees, voles do meadow lands a good deal of injury by eating off the crowns of the clover plants. Three hundred dollars would not repair the damage done to an orchard near the station. In 1863 trees 6 inches in diameter were stripped of bark clear up to the limbs 4 or 5 feet from the roots.
—Huron County, Mich., Oct., 1886.

The meadow mouse is very prolific. Its presence varies at periods from a few to countless numbers. Long droughts and inclement winters as well as natural enemies probably affect their numbers.
—Kansasville, Wis., Sept., 1888.

They damage hay by cutting the grass into lengths the size of toothpicks.
—Tower, Minn., June, 1895.

Mice eat celery put up in the garden. They also eat roots of grass if there is a heavy snow on the ground during the winter.

—Lewisburg, Union County, Pa., Dec., 1886.

Mice often cause serious trouble in the winter season by girdling fruit trees, especially apple and peach trees. They commit depredations on buckwheat fields. —Milan, Bradford County, Pa., 1888.

Our fields are subject to invasions of meadow mice during the winter when mulch is on them. A thousand of the mice wintered 1885–86 on a 2-acre strawberry patch. They eat the bark of trees when straw is placed about them or snow is on the ground. —Mexico, N. Y., 1886.

Meadow mice injure dams, banks, drains, and embankments.

—Gilbertville, N. Y., 1887.

Meadow mice injure vegetables; they are especially fond of beets. They injure meadows quite seriously when numerous by feeding on grass roots. They were extremely numerous in 1885, and ate potatoes in the hills.

—Little Valley, N. Y., 1887.

In some cases I have found a shock of corn with half the corn consumed by meadow mice. —Caldwell, N. J., Nov. 1, 1886.

The fields are full of mice. They are about the ears of standing corn, while that on the ground is mostly eaten. This is surely an invasion of mice. I can account for it only because last winter was so mild that all of them survived.

—Fairfield, Iowa, Nov., 1889.

Meadow mice are very destructive to the harvest fields, particularly in the shocks. They bite the ears of wheat and cut the twine bands off the sheaves. They gnaw young fruit trees in winter, if manure or straw is left close around the stem, and they kill the trees. —Willows, Griggs County, Dak., Dec., 188C.

Field voles eat wheat, rye, and other cereals, both green and when matured, and carry green grain as well as matured kernels into their burrows. They sometimes carry a half bushel of grain into a single hole. They damage fodder by cutting it. —North Topeka, Kans., May, 1890.

In the summer of 1884 we had an invasion of meadow mice [probably *M. townsendi*], and they did much damage. They destroyed seeds in the garden and ate growing wheat and oats in the spring, sometimes nearly destroying entire fields. They played havoc with the early peas and destroyed carrots and parsnips in the fall. The summer was unusually wet. The next summer was dry, and the mice disappeared. This is the only mouse year we have ever had here. During the year nearly all the cats died, apparently from eating the mice. They caught and ate them freely and were all affected alike. Some vomited more freely than others; they got puny, refused to eat, and died. Since the "mouse year" cats are themselves again.

—Aumsville, Oreg., Dec., 1886.

The bob-tailed mouse is a pest here, eating all kinds of bulbs, lilies, tulips, potatoes, etc. —Centerville, Mo., 1887.

Meadow mice ruined nearly the entire crop of clover in the winter of 1884–85.

—Wakeman, Ohio, 1886.

We are troubled with meadow voles. When we have much snow in winter they are very plentiful the next summer. Winter thaws, which leave the fields bare of snow, destroy them. They destroy fruit trees by gnawing the bark

under the snow. I think they will eat the bark from any kind of young trees. The damage is serious. —Montpelier, Vt., Nov., 1886.

Voles sometimes gnaw young apple and pear trees, mostly in winter; in summer also where red clover grows about the trees. The loss is serious. —Salem, Ohio. 1886.

Meadow mice are injurious to meadows and pastures by cutting the sod in winter. We had an invasion of them in the winter of 1864, when they killed grape vines, raspberries, and crab-apple trees 5 inches in diameter. —Stoughton, Wis., 1887.

Field mice are destructive to grain crops. Their depredations are mostly confined to the consumption of grain, but the injury by them depends upon the nut crop; if this is plentiful they do not disturb grain, or corn chiefly, but if there is a scarcity of nuts, they make incursions on the fields of corn, doing considerable damage. —Columbia, Conn., Sept., 1887.

The majority of the preceding reports refer to the common meadow mouse (*M. pennsylvanicus*) and its subspecies, but some of them from the Middle West undoubtedly include references to the prairie vole (*M. ochrogaster*), which is more numerous there. Most of the destruction to potatoes and stored vegetables may be attributed to pine mice.

REPORTS FROM NURSERYMEN AND ORCHARDISTS.

Early in March, 1906, a circular letter of inquiry asking for information in regard to damages by field mice was sent to more than a thousand representative nurserymen and fruit growers in the United States and southern Canada. Up to April 10, 1906, replies returned number 520, of which a summary is presented in tabular form.

Damages by field mice, as reported by nurserymen and fruit growers.

State or province	Number of circulars sent.	Number of replies received.	Mice abundant.	Mice not abundant.	Mice absent.	Damage by mice serious.	Damage not serious.	Damage none.	Number who make estimates.	Total of damage estimates.
Maine	8	4	2	2	......	2	1	1	2	$125
Mew Hampshire	11	7	5	2	......	4	3	......	2	100
Vermont	6	2	1	1	......	......	2	......	......	......
Massachusetts	40	23	11	12	......	7	10	6	7	865
Rhode Island	6	4	......	1	3	......	1	3	......	......
Connecticut	22	11	7	4	......	3	6	2	4	460
New York	85	34	24	9	1	20	7	7	16	8,275
New Jersey	23	12	6	6	......	3	8	1	4	750
Pennsylvania	37	27	22	5	......	13	11	3	15	3,100
Delaware	10	3	......	3	......	......	2	1	......	......
Maryland	20	12	6	6	......	3	4	5	2	35
Virginia	12	3	1	2	......	......	3	......	......	......
West Virginia	9	6	2	4	......	1	2	3	1	350
North Carolina	16	10	6	4	......	4	2	4	1	3,000
South Carolina	3	1	......	......	1	......	......	1	......	......
Georgia	16	8	......	2	6	......	1	7	......	......
Florida	6	5	[a]3	2	......	......	......	5	......	......
Alabama	22	9	......	5	4	......	1	8	......	......
Mississippi	9	3	......	1	2	......	......	3	......	......
Tennessee	18	7	2	5	......	......	2	5	1	25
Kentucky	30	18	3	15	......	2	8	8	1	75

[a] Probably not *Microtus*.

Damages by field mice, as reported by nurserymen and fruit growers—Cont'd.

State or province.	Number of circulars sent.	Number of replies received.	Mice abundant.	Mice not abundant.	Mice absent.	Damage by mice serious.	Damage not serious.	Damage done.	Number who make estimates.	Total of damage estimates.
Ohio	51	24	13	11		6	12	6	5	$700
Indiana	40	20	7	13		5	9	6		
Illinois	56	29	19	8	2	14	8	7	12	4,800
Michigan	43	19	13	6		7	8	4	5	1,400
Wisconsin	28	13	9	4		6	4	3	6	6,825
Minnesota	27	22	17	5		13	8	1	13	4,685
Iowa	49	26	22	4		16	7	3	4	2,500
Missouri	38	25	16	9		13	4	8	7	4,150
Arkansas	16	7	2	3	2		2	5		
Louisiana	10	6		a2	1		1	5		
Texas	18	10	a3	6	1		2	8		
Oklahoma	14	6		6			6			
Indian Territory	5	3		3				3		
Kansas	46	27	12	15		8	9	10	9	57,400
Nebraska	32	20	7	13		6	7	7	3	350
South Dakota	16	7	2	5		2	3	2		
North Dakota	6	5	2	2	1	2	1	2	1	100
Montana	11	8	3			2	1		1	500
Wyoming	1	1	1					1		
Colorado	10	3	1	1	1			3		
New Mexico	4	1			1			1		
Arizona	1	1			1			1		
Utah	5	3	2	1		1	2			
Nevada	0	0								
California	18	10	2	3	5	1	1	8		
Oregon	12	7	4	2	1	1	1	5		
Idaho	8	4	3	1		1	2	1	1	50
Washington	9	4		4		1	3		2	75
Ontario	17	4	4			4			3	6,500
Quebec	2	1	1			1				
Total	1,003	520	266	218	36	172	175	173	129	107,195

a Probably not *Microtus*.

Some comments on the above table are necessary. In reporting the abundance of mice nearly all the replies refer to present conditions. In many places where the animals are not now common they have been numerous in past years. In reporting damages many correspondents gave only personal experience, but did not answer the question as to damages in the neighborhood. Few of the persons who had sustained serious damages were able to estimate the amount of the losses, while many whose losses were slight made such estimates.

It will be noticed that in the South the injury from field mice is not serious, and that in the far West mice are troublesome in fewer localities than in the northern part of the country east of the Mississippi River.

Extracts from replies to the circular are here presented:

> Field mice are abundant here. They have done me a great deal of damage during the past year, principally on overgrown stock that I have not cultivated, allowing grass to grow around the trees. They were also very destructive to a lot of young date palms (*Phœnix canariensis*) grown close together in a bed.
>
> —West Berkeley, Cal.

> Field mice are abundant here. We lost about 200 fruit trees from their attacks in 1903. Other orchards and nurseries in this section have been badly injured.
>
> —Carlton, Mont.

Field mice are abundant in this vicinity, and in the winter of 1904–5 did much damage to orchards. In neighboring orchards, where girdling is claimed to be done by rabbits, I find that in five-sixths of the cases the injury is done by mice.
—Cokato, Minn.

We lost 2,000 trees in our orchards, not all killed—actual loss, about $4,000.
—Topeka, Kans.

Mice are abundant here this winter, and have girdled 5,000 trees in the nursery. —Moundsville, W. Va.

Field mice are abundant in North Carolina. On account of the general lack of snow in the vicinity of Raleigh they have not done serious damage to trees, but are very troublesome in gardens. The general observer charges moles with all the damage, but I have found that the mice, following in the mole runs, are the most serious enemies. Following under the sweet-potato ridges they gnaw the potatoes and do a great deal of damage. By using carbon bisulphid in the mole runs I destroyed more mice than moles, and became satisfied that the vegetable eating was mainly, if not entirely, done by the mice [pine mice].
—Raleigh, N. C.

In the winter of 1904–5 my loss in the peach orchard from mice was fully 10 per cent of the 1-year-old trees and 5 per cent of the 2-year-old. One 2-year-old peach orchard having turnips only on the ground was badly injured where snow was drifted. Another orchard in rather grassy corn stubble was injured in the same way. Peach seedlings in the nursery were also badly injured. —Aspers, Adams County, Pa.

Young trees and nursery stock were damaged by mice in 1904–5 when the snow was deep. It is difficult to protect nursery stock. The common skunk destroys field mice, and protecting the skunk is the best preventive of injury of which I know. —Collinsville, Hartford County, Conn.

Mice become worse every year, and its seems impossible to prevent damage now. This year, while there has been but little snow, they have damaged many trees. I have had 150 trees killed by mice in my orchard of 120 acres. They eat the bark from 8 inches below the surface of the ground to 12 or 15 inches above the ground. —Council Grove, Morris County, Kans.

A lot of the trees heeled in the ground over winter and covered heavily with leaves were damaged by mice. —Versailles, Ky.

During the winter of 1903–4 we had about 50 trees girdled in the orchard. Field mice seem to come as a scourge periodically. I can remember of from four to five seasons out of the past twenty-five when the pest was very, very numerous here. It seems almost incredible how all of a sudden they come and then seemingly mysteriously disappear. The country seems now to be almost free of them. —Center Point, Iowa.

Considerable damage has been done in the nursery, particularly to seeds of trees and shrubs, and also in girdling young trees under heavy snow. The mice [pine mice] work under mulching on trees and, in mole runs, on seeds and roots of some plants. —Saginaw, N. C.

No injury was noticed this open winter, but last year they girdled many young apple trees, both in the nursery rows and when heeled in.

Some few years ago this whole section suffered untold mischief by an unusual incursion of short-tailed field mice. They seemed to be everywhere, especially on roadsides and under hedges. While the snow lay deep they ate the bark from the roots of apple, locust, and some other trees, including the Osage orange.

This eating was always below the snow line or under cover of litter of any sort that hid the animals from the eyes of hawks and owls. These and foxes are their natural enemies.

The greatest absolute loss that season was in the destruction of red clover (*Trifolium pratense*). Many fields that went into winter with a beautiful aftermath of clover and other grasses came out in the spring bare of any profitable cover and had to be replowed, the clover roots having all been eaten out.

The favorite dainty with the mice is celery, when it is trenched in and covered with fodder. —Colora, Cecil County, Md.

Field mice are abundant here. While I have personally had no losses of trees from them, very many orchards and nurseries in this vicinity have been nearly ruined, especially where they were neglected and grass and weeds were permitted to grow. I prevent loss by thorough cultivation and by mounding up soil at the base of the trees late in the fall. —Boone, Boone County, Iowa.

I had perhaps 10,000 trees destroyed by mice and rabbits during the past five years, mostly by mice, in 1904 and 1905. Loss, $2,000. —Twin Bluffs, Wis.

Mice are abundant here. We have suffered no damage, but some young orchards have been completely ruined. They were left with quite a mulching of grass and cover. This made a harbor for the mice, and they girdled nearly all of the trees. —Oakland, Kans.

We lost $2,000 worth of nursery stock in 1904 and 1905.
—Rochester, N. Y.

We have a few thousand nursery trees destroyed by them each season.
—Charles City, Iowa.

Field mice abundant. My nurseries have been damaged to a great extent, especially last year during heavy snow. —Ellisville, Mo.

During the winter of 1903–4 mice were very abundant throughout the valley and, indeed, in most of the State. The damage to nurseries and orchards was about 25 per cent. Shade trees, as well as apple, were injured. The following summer the mice were exceedingly abundant in clover fields. Early in the spring they greatly disfigured lawns in the city and in the cemetery by burrowing on the surface of the ground under the snow. [The species in the valley is *M. pennsylvanicus modestus.*] —Bozeman, Mont.

Ten years ago we scarcely noticed any damage from mice. Some six years ago they began doing more or less damage and became very troublesome in the winter of 1903–4. They mowed off our two and three year old evergreens by the thousands, so that we had to rake over the beds before counting out trees to ship. We had piles of small trees the size of haycocks. I can not tell the money value, but think it much higher than I put it ($2,000).

I laid the trouble in this section to hunters. Hawks, owls, minks, skunks, etc., used to be very plenty, but they have nearly all been killed. Their principal food is mice. A short-eared owl wintered near our sheds in an evergreen, and you could hardly believe the piles of mice skins under that tree in spring.

Two years ago a pair of weasels took up their abode in our tree cellar, breeding there last year. They kept most of the mice killed off. In the summer we saw the old one quite often carrying mice to its young from outside the shed. * * * This winter has been very mild, with no snow. Mice have been plenty in meadows, but grass kept green and tender, and they did our nurseries little damage. —Waukegan, Ill.

ECONOMIC STATUS OF FIELD MICE.

The foregoing testimony as to the ravages of field mice sufficiently attests their noxious character. The extent to which they are beneficial to the farmer may be stated in few words. The upturning of the soil by gophers, ground squirrels, moles, earthworms, and various insects is an important part of its preparation for man's use, and field mice contribute to the work. In addition, mice diminish the number of weeds by eating the seeds and, possibly, occasionally devouring the roots.

The character of the vegetable matter eaten by field mice depends entirely upon the environment. If the animals live in swamps where rushes, sedges, and grasses useless to agriculture abound, their diet is confined to these, and the naturalist who investigates their food only in such surroundings may fall into the error of concluding that they are not injurious. But field mice at all times show a decided preference for cultivated plants and grains, if accessible, and in winter seek diligently for succulent roots and the green bark of trees.

REPRESSION OF FIELD MICE—NATURAL AGENCIES.

In view of their wide distribution and the nature of their habitats, the complete extermination of field mice is impossible. It is, however, entirely practicable to so reduce their numbers that crops shall be safe from serious attack. Before describing the methods which the farmer may use to destroy the animals, it is important to consider the natural agencies which aid in their repression.

CLIMATIC INFLUENCES.

Climatic conditions so strongly influence the natural increase of field mice that an understanding of their relation to such increase is important. It has been often noticed that the periods of greatest abundance of voles follow one or more open, warm winters succeeded by wet summers. If at the same time food—particularly grain—is abundant, the most favorable conditions for the increase of the animals are present, and the maximum number of young at a birth, as well as the maximum number of litters, are brought forth. When grain is abundant the young of some species are said to begin to reproduce when only 2 months old.

The continuance of favorable conditions for two or more years is sure to be followed by an enormous increase of field mice, with serious injury to crops.

Very cold winters without snow and summers of long droughts are unfavorable to the increase of field mice. Occasionally a severe frost following a heavy downpour of rain destroys nearly all field mice over large areas.

EPIDEMIC DISEASES.

Excessive multiplication of any mammal to the point of overcrowding is sure to be followed sooner or later by a fatal epidemic. Numerous instances of the prevalence of such diseases among rodents are known, and several of the historic mouse plagues were terminated by them. So complete was the destruction that several years of almost total absence of mice followed.

NATURAL ENEMIES OF FIELD MICE.

Prominent among the recognized causes for the great increase of rodent pests in recent years is the persistent destruction of the birds, mammals, and snakes that habitually prey upon them. Warfare against the natural enemies of noxious rodents is not confined to America. In the British Islands and on the Continent gamekeepers have systematically killed foxes, weasels, stoats, hawks, and owls, on the plea that they destroy game, and even farmers have joined in the warfare against the so-called "vermin." In America the same mistaken sentiment exists, and too often has led to ill-advised legislation against mammals and birds that are beneficial to the farmer. Wise measures for game protection can not be too highly commended, but ignorance of the true relations of animals and birds of prey to game is widespread even among lawmakers and sportsmen's clubs.

One of the most common mistakes made by sportsmen in the supposed interests of game protection is the offer of prizes for the destruction of alleged "game-destroying" mammals and birds. In one instance nine competitors for a club's prizes destroyed during twelve months 184 weasels, 48 foxes, 54 minks, 343 skunks, 15 great horned owls, 6 "common owls," and 148 hawks. The fact that only 21 owls were killed in an entire year by nine men trying for a record reveals a scarcity of these useful birds that is not complimentary to the intelligence of the community. The large number of skunks killed indicates ignorance or disregard of the usefulness of that animal in destroying insects and mice. Apparently, too, there was no discrimination as to the species of hawks destroyed, and it is probably safe to say that field mice in a single year have damaged the farmers of the region concerned a hundredfold more than the value of all the game and poultry saved through the offer of prizes.

The evidence presented to a committee of the British Board of Agriculture, who were investigating the Scottish vole plague of 1892, showed conclusively that in the affected district before the outbreak carnivorous animals and birds had been very scarce. The committee in their report emphasized the importance of protecting the birds, whose absence in the district in question was regarded as an important cause of the enormous multiplication of voles.

The chief natural enemies of field mice are (1) mammals, wild and domestic, (2) birds, and (3) snakes.

MAMMALS THAT DESTROY FIELD MICE.

WILD MAMMALS.

Among the wild mammals of the United States known to feed upon field mice are wolves, lynxes, foxes, badgers, raccoons, opossums, skunks, weasels, and shrews. A few of these feed upon mice habitually, and this habit, combined with their well-known service in destroying insects, compensates in great measure for the injuries they inflict in other ways.

Skunks are efficient in the destruction of mice and rats. The larger skunks (*Mephitis*), with about 17 species and subspecies, are distributed over most of the territory occupied by field mice. Their chief food is insects, but mice are second in importance on the bill of fare. Skunks not only search woods and meadows for mice but often come about barns and outbuildings in quest of the common mouse (*Mus musculus*) and brown rat (*Mus norvegicus*). While it is true that skunks sometimes destroy poultry, they do so much less frequently than is generally supposed. Comparatively few skunks learn to kill chickens, the habit being characteristic of the individual rather than of the species.

Of 36 skunks of the genus *Mephitis* whose stomachs were examined by the Biological Survey, two only, both captured in poultry houses, had eaten domestic fowls. There was no evidence that any of the 36 had destroyed game or small birds. The food consisted principally of beetles, grasshoppers, cicadas, crickets, rats, mice, and lizards. On account of their usefulness in destroying noxious insects and rodents, skunks deserve even more than the partial protection now afforded them by the laws of several States.

The habits of the little spotted skunks (*Spilogale*) are similar to those of the larger species. Like them, they are useful because they destroy insects and mice. Occasionally individuals learn to destroy domestic fowls, but the habit is even rarer than with the large skunks. As persistent and successful mousers about farm premises, they are unequaled and should be protected, the death penalty being reserved solely for the individuals that attack poultry.

The white-backed skunks (*Conepatus*) live in the South, mostly out of the range of field mice. They destroy many other kinds of rats and mice.

The mink (*Lutreola*) feeds commonly upon fish and other aquatic animals, but sometimes raids poultry kept near streams. It destroys meadow mice as well as other small rodents. The fur is in such demand, however, that minks are not likely to become sufficiently numerous to have much effect, good or bad, upon the interests of the farmer.

The various species of weasels and wild ferrets are persistent destroyers of meadow mice. The smaller weasels easily traverse the surface runways of the larger species of *Microtus* and even follow them into underground burrows. The larger weasels feed upon pocket gophers, prairie dogs, ground squirrels, and various kinds of mice and rats. While occasionally they capture game or song birds, as well as poultry, their principal food consists of injurious rodents.

The small American weasels, like European species, have an evil reputation among game preservers and farmers, who assert that weasels destroy the eggs and young of game birds, as well as young chickens and other fowls. However, stomach examinations, supplemented by careful field observations, show that small mammals form the principal food of weasels.. Among their prey are cottontail rabbits, little chief hares (*Ochotona*), prairie dogs, ground squirrels, wood rats, field mice, and the house mouse and brown rat.

A recent advance in the price of weasel skins in white, or winter, pelage has already caused a marked scarcity of these animals in some of the Northern States. The present abundance of meadow mice in the same States is attributable partly to the destruction of weasels. A correspondent in Minnesota, in a letter dated April 14, 1906, states that field mice were very abundant in his neighborhood during the preceding winter and caused much damage in orchards and nurseries. He adds: "The animals have never been so numerous here as during the last two years. I think weasels used to keep mice in check, but the high price of fur has made them very scarce."

Badgers, when not employed in unearthing larger rodents, devote much time and labor to digging out field mice. One will patiently excavate every burrow on an acre or more of ground, and, besides the litters of young, evidently get a large share of the old mice. Badgers have been caught with their intestines full of pellets of fur and bones of *Microtus*. Nevertheless, while doing almost no harm and while in general highly beneficial, badgers are destroyed almost everywhere, partly for sport, partly because on rare occasions one raids an unprotected chicken coop.

Foxes destroy many field mice and other rodents as well as many insects, especially grasshoppers, and thus do much to compensate for the poultry and game they kill. Although reliable testimony to the destruction of domestic fowls by the red fox (*Vulpes fulva*) is not wanting, the habit is by no means common, as is shown by the contents of stomachs examined by the Biological Survey. In three cases remains of the Gambel partridge were found and in one other a small bird. On the other hand, harmful rodents, including field mice, were found in over 20 stomachs. Besides these, a mole, a lizard, grass, corn, blueberries, and cultivated grapes show a somewhat miscellaneous diet. A writer in Forest and Stream states that in the stomach of a gray fox (*Urocyon cinereoargenteus*), taken at Milford, Conn., he found rabbit hair, parts of a field mouse, sweet corn, pieces of apple, remains of a woodcock, and some leaves.[a]

That shrews destroy many field mice is certain, although the evidence is largely circumstantial. It is known that they eat dead mice that have been caught in traps. It is proved that they are able to capture a live field mouse in its burrow by the fact that when both animals are confined in the same cage the shrew kills and partly eats the other animal. Shrews are often trapped in the burrows of field mice, and it is highly probable that they habitually feed upon the rodents. As they eat only the flesh and blood of their victims it is difficult to identify their food by stomach examinations.

The common brown rat (*Mus norvegicus*) is an enemy of field mice where both occur in the same locality. On the Potomac flats, south of Washington, D. C., both rats and meadow mice (*M. pennsylvanicus*) are abundant. On various occasions, while trapping mice there, specimens in small cage traps were destroyed by rats. Several times I had occasion to uncover burrows and runways of the mice by removing piles of dry weeds. On the following mornings I found that rats had enlarged the burrows in pursuit of mice, and the remains of fur and stains of blood on the ground showed that the pursuit had been successful. It is unfortunate that rats are even worse pests than the field mice they destroy.

Of the other wild mammals that destroy field mice—wolves, coyotes, lynxes, raccoons, and opossums—it may be said that the mouse-eating habit is not always prominent and that their economic status can not be determined by it alone. On the whole, however, their general effect in checking the increase of rodents must be regarded as an important item to their credit.

DOMESTIC MAMMALS.

Some of the domestic animals assist in the destruction ~~of field~~ mice. Cattle and horses in pastures undoubtedly trample upon and destroy many mice, especially the young. Hogs in fields and wood lots root them from burrows and nests and eat them. Aristotle mentions the ancient practice of turning swine among mice "to root up their runs."[b] But the more important of their enemies among domestic animals are dogs and cats.

Dogs follow the farmer to the field and at plowing and harvest are ready to pounce upon and kill every mouse that is uncovered in fur-row or shock. While they seldom eat rats or house mice, they sometimes become very fond of field mice and learn to hunt them independently. A good rat dog is undoubtedly a valuable asset of the farm, and I have known one to keep premises clear of brown rats (*Mus norvegicus*) when adjoining farms were overrun with them.

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[a] Forest and Stream, vol. 55, p. 464, Dec. 15, 1900.

[b] Aristotle's History of Animals, Book 6, chap. 30, p. 178, Bohn's edition, London, 1862.

Many cats are good mousers, both in house and field. Some live largely upon pocket gophers, ground squirrels, and field mice. Unfortunately, however, when cats roam afield they learn to destroy song birds, young poultry, and game. The ordinary farm cat is exceedingly destructive to small birds and game, and the number that cats annually kill is immense.

House cats usually are too well fed to make good mousers, and are believed to aid in the spread of infectious diseases among human beings. In spite of the usefulness of individual cats in destroying mice, every community would be better off for a large reduction in its feline population.

BIRDS THAT DESTROY FIELD MICE.

Many species of birds destroy rodents. Among those that eat field mice are shrikes, cuckoos, crows, herons, bitterns, storks, ibises, gulls, hawks, and owls. Unlike the mammals already named, some of these birds live almost exclusively upon field mice, and hence are of great assistance in reducing their numbers.

BIRDS OF PREY.

At the head of the list of bird enemies of field mice stand the hawks and owls. Most of the species habitually feed upon rodents, a few of them almost entirely. Moreover, the species that feed least upon harmful rodents feed largely upon insects. Thus the beneficial character of hawks and owls as a group is beyond question.

Fortunately the economic status of American hawks and owls does not rest upon mere theory or general assertions without proof. Bulletin No. 3 of the Biological Survey[a] deals with the food habits of hawks and owls of the United States, and is based upon examinations of nearly 2,700 stomachs. Such large series of the more common species were examined that further investigations can but confirm and emphasize the present verdict—that American hawks and owls, as a whole, are among the best friends of the farmer and that only a few species are more harmful than beneficial.[b]

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[a] The Hawks and Owls of the United States in their Relation to Agriculture, by A. K. Fisher, M. D., Washington, 1893.

[b] Doctor Fisher's report on the food of hawks and owls has long been out of print. For this reason some of the more important summaries of results, especially those relating to the mammal food, are given in this paper. Circular 61, Bureau of Biological Survey, Hawks and Owls from the Standpoint of the Farmer, gives a brief summary of the original report by Doctor Fisher, and may be had on application.

Hawks.—Though hawks are our most common birds of prey, many kinds are too rare to exert a marked effect, either injurious or beneficial, upon the interests of the farmer; but the most common kinds are widely distributed and their voracious appetites make them of considerable economic importance. Nearly all hawks feed more or less upon rodents, and their most frequent victims are the short-tailed field mice.

The marsh hawk, or harrier (*Circus hudsonius*), is probably the most common and most widely distributed North American species. It is of medium size and may easily be recognized, while flying low over fields and meadows, by its conspicuous white upper tail coverts. The results of an examination of 124 stomachs of this species are as follows: Seven contained poultry or game; 34, small birds; 57, mice; 22, other mammals; 7, reptiles; 2, frogs; 14, insects; and 8 were empty. Field mice were positively identified in 44 stomachs, averaging almost two to each stomach. Eight were found in one stomach. The other mammals were mainly ground squirrels (spermophiles) and rabbits.

The buzzard hawks (genus *Buteo*) include seven species and six subspecies, all rather large and slow of wing. They are rarely able to capture a domestic or wild fowl. They live chiefly on small mammals, insects, snakes, and batrachians. The group includes such well-known birds as the red-tailed hawk (*Buteo borealis* and four subspecies), red-shouldered hawk (*Buteo lineatus* and two subspecies), Swainson hawk (*Buteo swainsoni*), and broad-winged hawk (*Buteo platypterus*).

A summary of the food of 562 red-tailed hawks is as follows: Fifty-four of the stomachs contained poultry or game birds; 51, other birds; 278, mice; 131, other mammals; 37, batrachians and reptiles; 47, insects; 8, crayfish; 1, centipedes; 13, offal; and 89 were empty. Two hundred and twenty-eight stomachs contained 350 field mice.

Of 220 stomachs of the red-shouldered hawk 3 contained poultry; 12, other birds; 102, mice; 40, other mammals; 20, reptiles; 39, batrachians; 92, insects; 16, spiders; 7, crayfish; 1, earthworms; 2, offal; 3, fish; and 14 were empty. Sixty-three stomachs contained 89 field mice.

Of Swainson hawks, 18 stomachs were examined. Of these 7 contained small mammals; 8 contained insects; 3, reptiles; 3, batrachians; and 3 were empty. One of the mammals was a mouse, and nearly all the insects were locusts and grasshoppers. Throughout its summer range this species lives almost entirely upon grasshoppers.

Of broad-winged hawks, 65 stomachs were examined, 15 of which contained mice, and 13 other small mammals. No poultry or game birds were found in the stomachs, and the chief food was insects.

The most common Old-World representative of the genus is *Buteo buteo*, the common buzzard of England, and popularly known in Germany as the mouse buzzard (*Mäusebussard*). That the last name is well deserved, is shown from the researches of Dr. G. Rörig, of Berlin, who in 784 stomachs of this species found no less than 1,124 rodents, of which 1,057 were the common field mouse (*M. arvalis*).[a]

Two prominent species of rough-legged hawks (*Archibuteo*) occur in America. Both are winter sojourners with us. The northern form, the common rough-leg (*Archibuteo lagopus sancti-johannis*), summers north of the United States. The ferruginous rough-leg (*A. ferrugineus*), commonly known as the squirrel hawk, nests extensively in the Western States, but is more common there in winter. Both species are large and may be easily distinguished by the feathering of the legs, which extends to the base of the toes. Doctor Fisher examined 50 stomachs, all but 1 being of the common rough-leg. Of these, 40 contained mice only; 5, other mammals; 1, insects and a lizard; and 4 were empty. Of the 40 containing mice, 28 had meadow mice only, the number varying from 1 to 8 and the average being more than 3 to each hawk. These are winter records. In summer the birds doubtless are largely insectivorous. It is certain that the rough-legs do not often molest wild birds or domestic fowls.

The researches of Doctor Rörig make an equally favorable showing for the Old World rough-legged hawk (*Archibuteo lagopus lagopus*). He examined 250 stomachs of that species and found remains of 879 rodents, mostly field mice. Ninety-four per cent of the birds examined by him had eaten injurious rodents.[b]

The true falcons (genus *Falco*) of North America comprise 17 species and subspecies, of which 3 are accidental visitors from abroad, and several others, notably the gyrfalcons, are exceedingly rare within the United States. The various falcons differ much in size, but all are strong and swift of wing. The larger species destroy poultry and game, while the smaller kinds prey upon small birds and insects. All feed to some extent upon mice. The most common species are the duck hawk (*Falco peregrinus anatum*), the prairie falcon (*Falco mexicanus*), the pigeon hawk (*Falco columbarius*), and the sparrow hawk (*Falco sparverius*).

The duck hawk is a rather large falcon, and, as its name implies, preys much upon waterfowl. It destroys also game birds, domestic fowls, pigeons, and small birds. Although it feeds to some extent also upon insects and mice, the habits of the species, on the whole, do not commend it to the protection of farmers and sportsmen.

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[a] Arb. Biol. Abteilung für Land- und Forstwirtschaft, IV Band, 1 Heft, p. 64, 1903.

[b] Arb. Biol. Abteilung für Land- und Forstwirtschaft, IV Band, 1 Heft, p. 74, 1903.

The prairie falcon inhabits the West and Southwest. Its habits are somewhat similar to those of the duck hawk. It feeds largely upon land birds, mammals, and insects. Game birds and tame pigeons are known to be on its "bill of fare."

The pigeon hawk is smaller than either of the two preceding species, and is widely distributed in North and Middle America. It nests chiefly north of the forty-third parallel, except in the higher mountains. It feeds mainly upon small and medium-sized birds, a few field mice, and insects (chiefly dragon flies and grasshoppers). Fortunately for our summer song birds, the pigeon hawk for the most part is migratory within the United States. However, it accomplishes some good by destroying English sparrows.

The sparrow hawk is the commonest of our falcons. While it destroys some small birds, its chief food is insects and mice. It is too small to do much injury to poultry and game, and many of the small birds it captures are the injurious European sparrow. Doctor Fisher's report gives the results of examinations of 320 stomachs of the sparrow hawk. Of these, 1 contained a quail; 53, small birds; 89, mice; 29, spiders; and 29 were empty. The insects were largely grasshoppers, and about half of the mice were field mice.

Two common hawks of the genus *Accipiter* should be mentioned—the Cooper hawk (*Accipiter cooperi*) and the sharp-shinned hawk (*A. velox*). Both destroy many birds and feed only to a small extent upon injurious mammals and insects. The Cooper hawk destroys much poultry and game, while the sharp-shinned hawk lives chiefly upon smaller birds, including quail and young chickens. Although both species prey upon meadow mice, their limited usefulness in this respect does not offset their injurious habits. The thieving traits of these two birds has had much to do with the undeserved ill repute in which hawks as a whole are held.

All the other American hawks and eagles prey to some extent upon field mice. The kites (four species) are highly insectivorous. The Mississippi kite (*Ictinia mississippiensis*), known sometimes as the blue hawk, is locally abundant as a summer resident in southern Kansas, in Oklahoma, and parts of Texas. Its food is almost exclusively grasshoppers, and it seldom molests birds, yet it is often wantonly destroyed by sportsmen simply because it is a hawk and offers a tempting mark. The same may be said of the other kites, including the beautiful and useful swallow-tailed species.

The chief economic function of hawks seems to be the destruction of harmful rodents and insects. A majority of the species are decidedly useful, their good qualities far outweighing the bad. A few have no harmful habits, but are wholly beneficial. A smaller number have good and bad traits nearly balanced, or certain species may be beneficial in some localities but harmful in others. Two common species—the Cooper and sharp-shinned—destroy so many birds and poultry as to far outweigh any good they may do. If legislation against hawks is needed, which is more than doubtful, careful discrimination should be exercised as to the species placed under ban, and corresponding protection should be given those that are of undoubted benefit to the farmer.

OWLS.—Owls are preeminently enemies of mice. Their eyes are adapted to twilight and nocturnal hunting, and they prey mostly upon animals that are active after sunset. Noiseless of wing and possessed of sharp talons and much strength, they attack small mammals with great success.

Owls, and also hawks and some other birds that eat small vertebrates by swallowing them entire, are unable to digest the bones, fur, and feathers. These are thrown up in the form of pellets, the bones being surrounded by fur and feathers. Much of our knowledge of the food of owls is derived from examinations of these pellets.

The American barn owl (*Strix pratincola*) is rather common in the southern half of the United States, breeding as far north as forty-one degrees. In part of its range field mice are common and it preys upon them to a considerable extent. Examinations of 39 stomachs of barn owls were made by Doctor Fisher. Of these, 1 had eaten a domestic pigeon; 3, other birds; 17, mice; 17, other mammals; 4, insects; and 7 stomachs were empty. Meadow mice were found in 9 of the stomachs. The mammals eaten, other than mice, were chiefly ground squirrels (spermophiles) and other injurious species.

Doctor Fisher records the results obtained from an examination of 675 pellets of the barn owl collected at Washington, D. C. They contain remains of 1,731 rodents, 56 insectivorous mammals, 32 birds, and 2 frogs. The rodents were mainly rats (*Mus norvegicus*), house mice (*Mus musculus*), and meadow mice (*Microtus*). Of the last there were 1,123 skulls, or an average of almost 2 to each pellet.[a] Doubtless similar investigations in California, where these owls are common, would show that there spermophiles are the chief food.

The habits of the European barn owl (*Strix aluco*) serve to illustrate further the usefulness of our own bird. Dr. Bernard Altum, a German naturalist, in 1863 recorded the results of examinations of 703 pellets of the barn owl. He found remains of 16 bats, 933 rodents, 1,479 shrews, and 22 small birds (19 of which were sparrows). Of the rodents 693 were voles.[b] Later (1867) he published the results of examinations of 360 additional pellets, making 1,063 in all. The total shows 2,151 insectivorous mammals, and 1,801 rodents, of which 1,284 were voles.[c]

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[a] Science, N. S., vol. 3, pp. 623–624, Apr. 24, 1896.

[b] Journal für Ornithologie, vol. 11, pp. 41–46, 217–219, 1863.

[c] Zoologische Garten, vol. 8, pp. 263–264, 1867.

The Reverend Doctor Jäckel, of Windsheim, Bavaria, collected and examined a total of 6,512 pellets of the barn owl. In them he identified skulls of 5,210 shrews and 14,790 rodents, of which 9,046 were *Microtus*.[a] Doctor Rörig more recently examined 121 pellets of barn owl and in them identified 291 voles, 68 true mice, 35 shrews, and 13 sparrows,[b] a result more in harmony with Doctor Fisher's tables.

John Watson calculates that each pair of owls of this species while feeding their young capture at least 40 mice per day. Once he found no fewer than 17 recently killed field mice on the side of a barn owl's nest which contained 5 young owls.[c] The late Edward Newman stated that every owl of this species is worth £5 per year to the British nation.[d]

The long-eared owl (*Asio wilsonianus*) is distributed throughout temperate North America, except the treeless plains. It is a constant resident over most of its range, and its usefulness in the destruction of mice continues throughout the year. Of the 107 stomachs examined by Doctor Fisher, 1 contained a quail; 15, other birds; 84, mice; 5, other mammals; 1, insects; and 15 were empty. Of the 84 containing mice, 46 contained specimens positively identified as meadow and pine mice. About 50 pellets cast up by long-eared owls contained 176 skulls, representing 93 meadow mice, 19 pine mice, 23 other mice, 26 shrews, and 13 small birds.

The long-eared owl (*Asio otus*) of the Old World has a similar record. Doctor Rörig made 108 stomach examinations of this species. In the stomachs he identified 20 small birds, 1 weasel, 2 bats, 18 shrews, 29 true mice, 14 bank voles (*Evotomys*), and 365 field mice (*Microtus*). Nine stomachs contained insects. Eighty-four per cent of the birds had eaten mice. A single stomach contained 12 field mice.

In 142 pellets of *A. otus* examined by Doctor Altum, he found 3 small birds, 2 shrews, 14 true mice, 12 bank voles, and 259 voles (1 *M. amphibius*, 65 *M. agrestis*, and 193 *M. arvalis*.[e] Doctor Rörig examined 1,053 pellets of long-eared owl and found remains of 14 small birds, 1 frog, 2 moles, 29 shrews, 22 true mice, 15 bank voles, and 1,764 voles. Selby found 5 mice in a single stomach of this species.

The short-eared owl (*Asio accipitrinus*) is probably the greatest enemy of field mice. It figures in many historical accounts of vole plagues in England and on the Continent. Holinshed's Chronicle closes the account of voles in Danesey Hundred, of the county of

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[a] Zoologische Garten, vol. 15, p. 469, 1874.

[b] Arb. Biol. Abteilung für Land- und Forstwirtschaft. IV Band. 1 Heft, pp. 102–104, 1903.

[c] Ornithology in Relation to Agriculture and Horticulture, p. 12, London, 1893.

[d] Hardwicke's Science Gossip, vol. 29, pp. 89–90, 1893.

[e] Journal für Ornithologie, vol. 12, pp. 429–434, 1864.

Essex, in 1581, by saying: "Which vermin by policie of man could not be destroyed, till at the last there flocked together such a number of owles as all the shire was not able to yield, whereby the marsh holders were shortly delivered from the vexation of the said mice." Similar testimony as to the efficiency of owls as destroyers of voles is contained in other chronicles, and in the account of later outbreaks the species is definitely stated to be the short-eared owl.

The short-eared owl inhabits the temperate parts of both continents. In each its range extends northward well beyond the Arctic Circle. It is an irregular migrant and always appears in large numbers where voles, lemmings, or other mice become unusually abundant. It nests on the ground in tall grass, usually in moist meadows, a habitat peculiarly fitted for the operations of this consumer of meadow mice. Doctor Fisher reports the results of examinations of 101 stomachs of this species. Of these, 11 contained small birds; 77, mice; 7, insects; and 14 were empty. In the 77 stomachs that contained mice fully a hundred field mice were identified. Doctor Rörig examined 51 stomachs of this species and found in them remains of 90 injurious rodents, of which 76 were *Microtus*. He examined also 480 pellets of this owl, finding remains of 3 beetles, 9 small birds, 7 bank voles, 22 *Microtus agrestis*, and 842 *M. arvalis*.

For purposes of comparison, the results of the examinations of owl pellets are here presented in tabular form. The figures, disregarding fractions, represent the average number of individual mammals and birds found in 100 pellets of each species of owl.

Kind of mammal or bird found in owl pellets.	Barn owl.				Long-eared owl.			Short-eared owl—*Asio accipitrinus* (Dr. Rörig).
	Strix pratincola (Dr. Fisher).	*Strix aluco* (Dr. Altum).	*Strix aluco* (Rev. Jäckel).	*Strix aluco* (Dr. Rörig).	*Asio wilsonianus* (Dr. Fisher).	*Asio otus* (Dr. Altum).	*Asio otus* (Dr. Rörig).	
Harmful rodents:								
Mus (rats and mice)	87	48	87	56	46	10	2	0
Microtus (field mice)	166	121	139	241	114	182	168	180
Other rodents	3	[a] 4	[a] 1	0	0	[a] 8	[a] 2	[a] 1
Insectivorous mammals (shrews, moles, and bats)	8	202	80	29	52	1	3	0
Small birds (sparrows, etc.)	5	3	(b)	11	26	2	1	2

[a] Bank voles (*Evotomys*).

[b] Not given.

The barred owl (*Syrnium varium*) is larger than the species already considered. It resides throughout eastern North America from Nova Scotia to the Gulf and westward to the treeless plains. It usually lives in rather dense forests and swamps and nests in hollow trees. Owing to its greater size, its food includes larger mammals and birds than that of the last three species. Thus, it is able to carry off a good-sized domestic fowl, and no doubt occasionally it raids poultry. However, Doctor Fisher's examination of 109 stomachs of this species indicates that it is far less harmful than is generally supposed. Five stomachs contained poultry or game; 13, other birds; 46, mice; 18, other mammals; 4, frogs; 1, lizard; 2, fish; 14, insects; 9, crayfish; and 20 were empty. Field mice were positively identified in more than half of the 46 stomachs that contained mice.

The great horned owl (*Bubo virginianus*) is the largest owl resident in the United States. Its range, including the subspecies, extends from Costa Rica to the northern limit of deep forests and from ocean to ocean. In South America occur a number of closely related forms.

The great horned owl has an evil reputation with most farmers on account of its destruction of poultry. The bad reputation is only partly merited. Doctor Fisher examined 127 stomachs of this species. Of these, 31 contained poultry or game birds; 8, other birds; 13, mice; 65, other mammals; 1, a scorpion; 1, a fish; 10, insects; and 17 were empty. About half the mice found were meadow voles and the majority of the "other mammals" were rabbits. In central Kansas, some years ago, I examined over a dozen nests of this species in which young were being fed. The nests contained rabbits (*Lepus floridana mearnsi*), fox squirrels (*Sciurus rufiventer*), wood rats (*Neotoma baileyi*), skunks (*Mephitis*), field mice, and in two cases feathers of the flicker (*Colaptes auratus luteus*), but in no case any feathers or remains of poultry. In the few cases in which these owls were observed by me to raid poultry the fowls were roosting upon trees late in the fall, and hence were unnecessarily exposed to attack. Where rats are abundant this owl has been known to prey largely upon that rodent. O. E. Niles, in a letter to Charles Dury, dated March 5, 1885, stated that at one time the remains of no less than 113 rats had been counted under the nest of a great horned owl.[a] On the whole, the great horned owl is not a very harmful species, and as it is rapidly disappearing in most parts of the United States warfare against it may be suspended.

The screech owl (*Otus asio*) is probably the most familiar of American owls. Including its ten or more geographic races, it has a wide distribution. It is too small to prey upon domestic fowls or game and is beneficial. Doctor Fisher reported on the contents of 255 stomachs, of which 1 contained a tame pigeon; 38, other birds; 91, mice; 11, other mammals; 6, lizards and batrachians; 1, fish;

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[a] Jour. Cin. Soc. Nat. Hist., vol. 8, p. 63. 1885–86.

100, insects; 5, spiders; 9, crayfish; 11, miscellaneous; and 43 were empty. A good proportion of the "other birds" were English sparrows. About a third of the mice were identified as meadow mice, while 24 were house mice. The large proportion of insects eaten is remarkable.

The burrowing owl (*Speotyto cunicularia hypogæa*) is a small species, common on western plains, and noted for its abundance during summer in prairie-dog "towns," where it occupies the deserted burrows of that rodent. Of 32 stomachs of this owl examined by Doctor Fisher, 2 contained mice; 1, a prairie dog; 3, lizards; 3, scorpions; 1, a centiped; 30, insects, and 1 was empty. The species is largely insectivorous and undoubtedly highly beneficial.

Several other species of owls occur in the United States, but at no season are they abundant over any considerable area. Probably all feed largely upon meadow mice. Doctor Fisher's report covered only a small series; but 6 out of 9 great gray owl stomachs, 4 out of 22 sawwhet owl stomachs, 10 out of 38 snowy owl stomachs, and the single hawk owl stomach examined contained the remains of field mice.

From the testimony of Doctors Fisher, Altum, Jäckel, and Rörig, and careful observations by others, the great value of owls for reducing the number of meadow mice is established beyond doubt, and the various species should everywhere be protected by legal enactments.

CROWS.

Among the most formidable bird enemies of field mice are the larger members of the crow family (*Corvidæ*). The fact that ravens, hooded crows, and rooks in the Old World feed upon voles and lemmings has often been noted. American crows have similar habits and feed upon field mice whenever occasion offers. Besides the common crow (*Corvus brachyrhynchos*) the list of mouse-eating crows includes the fish crow (*Corvus ossifragus*), the northwest crow (*Corvus b. caurinus*), the raven (*Corvus corax sinuatus*), and the white-necked raven (*Corvus cryptoleucus*). Magpies and the larger jays also destroy mice to some extent.

The food habits of the common crow form the subject of Bulletin No. 6 of the Biological Survey.[a] The results of examinations of 909 stomachs of crows are tabulated in the report. Of this number, 78 contained mice, they being fourth in order of importance on the list of animal food for the year. Professor Barrows says: "There is abundant proof from several sources that crows often capture living mice, particularly the short-tailed field mice, which build their nests usually on the surface of the ground among the roots of grass. Here the crows discover them, and, tearing the nest to pieces, devour the young and not infrequently catch the adults as well. By far the greater number of the mice found in the stomachs were meadow mice, or voles (genus *Microtus*), and most of them were the common species (*Microtus pennsylvanicus*)."

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[a] The Common Crow of the United States, Walter B. Barrows and E. A. Schwartz, 1895.

In midwinter, when the ground is covered with snow, crows find but few field mice; but as spring approaches and the snow begins to melt on the meadows, the bulky grass nests of the mice are first exposed. The crows may then be seen searching the meadows for them. They alight near the openings in the snow, pounce upon the nests, tear them to pieces, and as the mice scamper out the crows often succeed in capturing them. Later in the spring, when crows feed their nestlings, insects are more abundant and the nests of mice are hidden in the growing grass, so that relatively fewer mice are eaten. Still later, after the young crows have left their nests and mowing machines have once more exposed mouse nests in the meadows, crows again spend much time searching for young meadow mice.

It is of interest to note that complaints of recent depredations of field mice are especially numerous from sections of the United States where for several years past bounties have been paid for killing crows.

CUCKOOS AND SHRIKES.

The larger species of the family of cuckoos (*Cuculidæ*) are known to feed extensively upon vertebrates. The two more common cuckoos of the United States are too small to share this habit, but the roadrunner (*Geococcyx californianus*) of the Southwest feeds rather commonly on reptiles, batrachians, and small rodents. Prof. F. E. L. Beal captured one in California which had eaten a field mouse (*M. californicus*).

The great northern shrike (*Lanius borealis*) is a common winter visitor in the northern half of the United States. It arrives from the north in October and remains until March or April. It is a familiar bird to most residents of rural districts. Gray in general color, with black wings, conspicuously barred with white, and with white in the tail, it looks much like a mocking bird, but has a strong, sharply-hooked bill, which enables it to kill small birds and mice. In its summer home it is probably much more insectivorous than with us. It comes to the United States at a time when insects are not abundant, and feeds mainly upon small birds, mammals, and grasshoppers. Mice were found in one-third of the stomachs examined by the Biological Survey and more than half of those identified were meadow mice. Doctor Mearns is quoted[a] as authority for the statement that in Minnesota during March shrikes live almost exclusively on meadow mice. Most farmers have noticed that the northern shrike, or "butcher bird," catches meadow mice. The birds are often seen at husking time as they hover in the air or sit on a fence post or top of a hedge, ready to pounce upon every mouse that escapes from corn shocks as they are torn down or moved.

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[a] Bulletin 9 of the Biological Survey, Cuckoos and Shrikes in their Relation to Agriculture, p. 19, 1898.

The smaller shrikes (*Lanius ludovicianus* and subspecies) also somewhat resemble mocking birds in color. They are summer residents of many parts of the United States. As insects are abundant during the greater part of their stay, they are insectivorous to a greater extent than the northern shrike. Stomach examinations prove that mice form 16 per cent of the food for the entire year, but the birds are less able than the larger species to cope successfully with adult meadow mice, yet they undoubtedly destroy a good many voles, and several have been identified in their food; but smaller mice are more frequently caught.

Although shrikes destroy a few useful birds, they more than compensate for this by their destruction of small rodents and insects, and they fully merit protection by the farmer.

OTHER BIRDS.

Members of the order *Herodiones*, including herons, storks, and ibises, are usually persistent enemies of meadow mice. Many of them frequent meadows and swamps, especially in the breeding season. Unfortunately, the summer range of the larger number of species is too far south to bring them much in contact with voles. However, a few species spend the summer where mice abound and make them an important part of their food.

Of our herons, the American bittern (*Botaurus lentiginosus*) is probably the best known destroyer of voles. The bird is a summer resident in all suitable localities in temperate North America, making its home in moist meadows, bogs, and swamps. Baird, Brewer, and Ridgway say of it: "It does not move about much by day, although it is not strictly nocturnal, but is sometimes seen flying low over the marshes in pursuit of short-tailed or meadow mice, which are frequently taken whole from its stomach."[a] Records of the Biological Survey contain a number of instances in which meadow mice were found in stomachs of this species.

Among other *Herodiones* that feed upon meadow mice are the least bittern (*Ardetta exilis*), wood ibis (*Tantalus loculator*), great blue heron (*Ardea herodias*), American egret (*Herodias egretta*), snowy heron (*Egretta candidissima*), and the black-crowned night heron (*Nycticorax nycticorax nævius*). While frogs, fish, and fresh-water crustaceans form the major portion of their food, they feed also upon mice, shrews, and other small mammals. As a group they undoubtedly effect a reduction in the numbers of meadow mice in America.

During a plague of field mice (*Peromyscus* in this case) in South America in 1872–73 Mr. W. H. Hudson observed that storks became very numerous. He says: "In the autumn of the year [May, 1873] countless number of storks (*Ciconia maguira* [*Euxenura maguira*]) and short-eared owls (*Asio accipitrinus*) made their appearance. They had also come to assist in the general feast. * * * Years have perhaps passed during which scarcely an individual of these kinds has been seen; all at once armies of majestic white storks are seen conspicuously marching about the plain in all directions, while the night air resounds with the solemn hootings of innumerable owls."[a] European writers bear testimony to the usefulness of the common stork (*Ciconia ciconia*) in destroying voles and other kinds of mice.

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[a] The Water Birds of North America, vol. 1, p. 70, 1884.

The family of cranes (*Gruidæ*) range farther north than the herons, and the three North American species are known to feed to some extent upon voles, capturing both young in the nests and adults. The habitat of cranes includes upland prairies as well as moist meadows, and thus probably they prey upon more species of voles than herons do.

Although the usual food of gulls (*Laridæ*) consists of fishes and insects, they feed also upon rodents. During the vole outbreak in Scotland in 1892 several species of gulls, notably the great black-backed gull (*Larus marinus*), fed upon the field mice; and gulls are usually named among the species that feed upon lemmings during their migrations. It is highly probable that the larger American gulls feed upon field mice whenever they find them.

SNAKES.

Snakes must be included among the natural enemies of field mice. While nearly all snakes feed extensively upon insects, many of them eat vertebrates, including fishes, reptiles, batrachians, birds, and mammals. The larger bull snakes (*Pituophis*), black snakes (*Callopeltis*), and rattlesnakes (*Crotalus*) of the United States feed largely upon mammals, including rabbits, prairie dogs, pocket gophers, and ground squirrels, as well as different species of rats and mice. Black snakes and bull snakes probably kill more field mice than the others; but black snakes destroy also a considerable number of nestling birds and birds' eggs, so that part of their beneficial work is offset by this injurious habit. A nurseryman in Pennsylvania reports that he secured immunity from mice in his nursery by turning loose in it 50 black snakes. On the whole, snakes, except the venomous species, are deserving of the farmers' protection. Like the toad, the smaller kinds feed almost wholly upon insects; but an inherent prejudice induces thoughtless people at every opportunity to destroy these friends of agriculture.

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[a] Naturalist in La Plata, pp. 64-65, 1892.

REPRESSION OF FIELD MICE—ACTIVE MEASURES.

We pass now to a consideration of such means for the repression of voles as are under the immediate control of the farmer. These consist of trapping and other mechanical methods of destruction and the use of poisons, fumes, and micro-organisms.

TRAPPING.

Trapping is a simple way to destroy field mice, but it is seldom resorted to because few people have patience to follow it up persistently and to look after the necessary large number of traps. When field mice are abundant it is essential to use many traps and to continue trapping for several weeks. Equipped with a hundred or more effective traps, a good trapper should be able to make decided inroads upon the numbers of the pests, if not to practically exterminate them over a limited area.

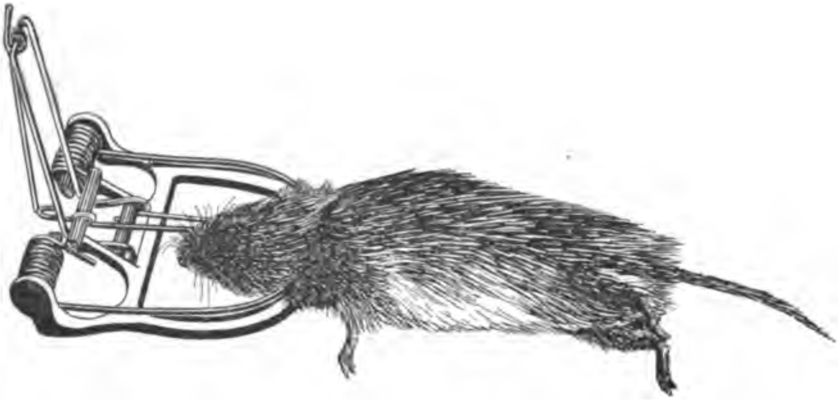

FIG. 2.—Field mouse caught in baited guillotine trap.

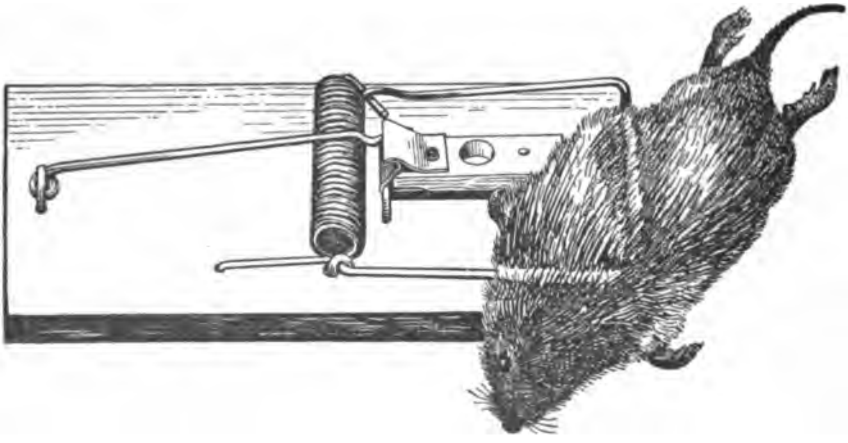

FIG. 3. Field mouse caught in unbaited guillotine trap.

Trapping has special advantages for small areas such as lawns, gardens, and vegetable or nursery pits and packing houses, where a limited number of mice are present, and wherever, for any reason, there are objections to the laying out of poison. As voles do not readily enter cage traps, simple wire traps of the guillotine order, in which mice are instantly killed, are the most effective (text figures 2 and 3).

Traps without bait may be set across the runs of the mice, where the animals spring them by coming in contact with the trigger, or they may be baited with oat or corn meal. For trapping pine mice an opening should be made in the underground tunnel large enough to receive the trap, which should be set across the bottom of the runway. The traps may be baited or not, but the opening should be covered.

CULTIVATION.

Thorough cultivation of fields tends to keep down the number of voles. Cultivation implies the destruction of weeds and all the annual growths that provide winter shelter for the animals. The mere plowing of a field badly infested by mice is sufficient to drive out most of them. However, as a rule the animals escape to adjoining fields and return to their old haunts when growing crops or weeds afford sufficient shelter.

The Scottish vole plague of 1892–93 originated in hill pastures, where heather, moss, and numerous grasses afforded abundant shelter. The outbreak on the border farms in 1876–77 occurred under similar conditions. The Thessalian vole plague of 1891 and 1892 apparently grew out of peculiar conditions of cultivation. The district visited by the mice is an extremely fertile one on the plains near Larissa. The lands are mostly in large holdings, the owners of which rent the fields to peasants who live in the villages. Owing to primitive methods of cultivation, each peasant has only a small tract. As the number of renters is small, a system of rotation is practiced which brings the same tracts into cultivation about once in three years, while two-thirds of the district lies fallow. In the fallow lands voles multiply until at times they invade the cultivated lands and ruin the crops.[a]

While a high state of tillage does not always bring immunity from voles, it does much to lessen the danger of attacks from them. A system which regularly brings all the land of a district under the plow and permits little of it to lie unused will secure the greatest immunity from these pests.

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[a] Prof. T. Loeffler, Centralblatt für Bakteriologie und Parasitenkunde, vol. 12, pp. 1–17, July 5, 1892.

OTHER MECHANICAL DEVICES.

Mechanical methods of destroying voles have long been in use, and sometimes are effective. In some countries where the animals are abundant, considerable reliance is placed upon the efforts of laborers armed with spades and other digging tools and assisted by dogs. In this manner thousands are sometimes killed.

Trenching also is a favorite method of catching both mice and moles. Trenches a foot and a half deep are dug at intervals about the infested lands. They are wider at the bottom than at the top, or have perpendicular sides. The animals fall into these pits and are unable to climb out. Men and dogs regularly make the rounds and despatch the animals thus caught. This method was used effectively in Dean and New Forests in 1813 and 1814 and in the later vole plagues of Great Britain and central Europe.

Inundation with water and fumigation with sulphur have been employed to some extent in killing field mice. All these mechanical methods involve much labor and are slow and often expensive.

POISONING.

As the laying out of poison for wild animals is attended by danger to other animals and to human beings, it should never be intrusted to the ignorant or careless. In some countries the laying of poison is forbidden by law, and several of our own States have enactments regulating the practice or forbidding it. The majority of States have no legislation prohibiting the use of poison, and the matter is usually left to the judgment of the individual farmer, to whom attaches responsibility for any damage that may result through his carelessness.

STRYCHNINE.

All things considered, strychnine is the most satisfactory poison for field mice. Although a very deadly substance, it is less dangerous to handle than either phosphorus or potassium cyanide. Its extreme bitterness renders it less liable to be mistaken for a harmless drug. Nevertheless, every precaution should be taken in handling it. The strychnine salt most used commercially is strychnia sulphate. This is the best for poisoning purposes, since it is soluble in boiling water, while the alkaloid requires the presence of an acid for its solution. To disguise the bitterness of the poison when employed for rodents, sugar is used, or the strychnine may be mixed with its own bulk of commercial saccharine.

For poisoning field mice various baits may be recommended, such as wheat, oatmeal, and corn, among the grains, and seeds of various plants, as the tomato, dandelion, sunflower, and others. The bait should be soaked over night in a poisoned sirup, which may be prepared as follows:

Dissolve an ounce of strychnia sulphate in a pint of boiling water; add a pint of thick sugar sirup and stir thoroughly. The prepared sirup may be scented by a few drops of oil of anise or rhodium, but this is not essential. A half ounce of borax is said to keep the mixture from molding.

The above quantity (a quart) of sirup is enough to poison a half bushel of wheat or corn, but smaller proportional quantities of grain and sirup may be mixed as needed. If after thorough mixing the solution is not sufficient to wet all the grain, add a little water. After standing over night, if the grain is too wet, a little dry corn meal will take up the excess of moisture. If oatmeal is used as a bait, when the mass is wet throughout with the sirup, it may be used immediately.

Because of the danger of destroying native birds, such as quail, sparrows, and others, the poisoned bait should not be placed in exposed situations, but under shelters which will admit mice but exclude birds. Wide boards lying upon thin cross pieces of wood are excellent for the purpose. For pine mice baits may be placed in the underground tunnels without endangering birds. For other mice pieces of drain tile about 1½ inches in diameter may be laid along the trails, and the baits inserted into the tiles with a long knife or spoon. Tiles are recommended by the French Minister of Agriculture, but old tin cans with flattened ends or small openings are excellent substitutes.

In winter the following plan is especially recommended for orchards and nurseries:

Cut small twigs from branches of apple trees (suckers are excellent for the purpose) and either dip them in the strychnine sirup or apply the sirup to them with a brush. Scatter the poisoned twigs near the trees to be protected. This plan is excellent for either field mice or rabbits, and it entirely obviates the danger of poisoning birds or domestic animals.

OTHER POISONS.

Among other poisons that have been recommended for the destruction of field mice are phosphorus, potassium cyanide, and various mineral poisons, including arsenic. The mineral poisons as a rule are less virulent than the others.

Phosphorus, when properly used, is an excellent though rather slow poison for rodents, a very small quantity producing death. It is, however, dangerous to handle both because of the liability of severe burns and because of the danger of serious conflagrations. Its use in the West to destroy ground squirrels frequently results in the burning of standing grain and in extensive prairie fires. For these reasons we do not recommend its use for poisoning mice.

Potassium cyanide is a most deadly poison, almost tasteless, and with no known antidote. It is therefore dangerous to man, and its general use for poisoning rodents can not be recommended. It is open to the further objection that upon exposure to air it rapidly decomposes and becomes less effective.

Among the mineral poisons that have been successfully employed in destroying field mice is barium carbonate. This substance is comparatively cheap, and is both odorless and tasteless, so that rodents do not detect its presence in food. Its action in the digestive tract of rats and mice is slow, but reasonably sure to produce death. Larger animals are not affected by small doses of the poison, such as would be put out to kill mice; and for this reason its use is attended with less danger than that of strychnine or arsenic.

This poison is usually administered in the form of dough made of four-fifths flour or meal and one-fifth barium carbonate. A little sugar is added to sweeten the mixture, and, if desired, a couple of drops of anise oil. The dough is cut into small lumps (the size of a large pea) for mice, but larger ones are required for rats. The poison may be fed also in moistened bread or oatmeal.

Although the advantages of barium carbonate as a rodent poison have been long known, it has recently been brought into prominence on account of successful experiments in destroying field mice with it made by Dr. Lorenz Hiltner, of Munich, Germany,[a] and by E. Schribaux in France.[b]

Winter is the most favorable season for poisoning field mice. Summer poisoning is usually less successful, on account of the abundance of green food. Although the animals are active in nearly all kinds of weather, they move about more freely in winter when it is comparatively warm. For the best results, therefore, poison should be set out in the evening of rather mild days. Since mice usually work under the snow, it is useless to put out poison for them on the surface of the snow.

The importance of protecting birds during poisoning operations can not be too earnestly insisted upon. In France, in 1905, a great scarcity of birds, particularly partridges, was noticed in the departments of Vienne, Deux-Sevres, and Charente, which was attributed to the extensive use of poisons during 1904 to destroy field mice.[c]

Says the editor of Western Field, of San Francisco, Cal.: "In two or three counties in this State—notably in that of Santa Barbara—the quail, dove, and song birds are being threatened with actual extermination from poison put out by farmers with the intent of killing off the ground squirrel pests. The poison has been scattered indiscriminately over wide areas, and reliable observers keep sending in reports of their finding thousands of dead birds of all kinds, victims of the squirrel bane."[d]

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[a] Praktische Blätter für Pflanzenbau und Planzenschutz, vol. 1 (new series), pp. 112–116, November, 1903.

[b] Journal d'Agriculture Pratique, vol. 9 (new series), No. 22, pp. 708–710, 1905.

[c] Journal d'Agriculture Pratique, Sept. 14, 1905, p. 327 (quoting the Journal Temps).

[d] Western Field, vol. 8, No. 1, p. 57, February, 1906.

ADDITIONAL METHODS OF POISONING.

The following recipes and recommendations contain useful hints to farmers who for any reason do not wish to follow the recommendations already made:

To protect trees from mice we take blocks of wood 6 inches in length by 3 in diameter, and with a six-quarter auger bore a hole 4 inches in depth. Mix a dessert spoonful of arsenic with a quart of corn meal, or in that proportion, put one spoonful in each box prepared as above, and put it under each tree beneath the mulch. Renew the meal once or twice each year. This process is a sure protection.—Lewis H. Spear, in U. S. Agricultural Report for 1852, p. 153.

Different poisonous preparations have been used with effect on these vermin. The following are among the best:

Two ounces of carbonate of barytes, mixed with a pound of suet or tallow; place portions of this within their burrows or about their haunts. It is greedily eaten, produces great thirst, and death ensues after drinking. This is an effective poison, as it is both tasteless and odorless. Or,

Two ounces finely powdered arsenic, 2 ounces lard, 10 drops oil of rhodium, mixed with flour or meal into a thick dough, and pills of it scattered about the orchard and nurseries.—E. A. Samuels, in U. S. Agricultural Report, 1863, p. 272.

These animals (*M. agrestis*) had devoured the succulent flower stems of some hundred *Lobelia cardinalis* and the fleshy stems of Pampas grass (*Arundo conspicua*). After making a number of futile experiments, I noticed the animals feeding on dandelion seeds. Securing some ripe heads of dandelions and cutting off the down, I steeped them in a solution of strychnine and laid them in the runs of the voles. In a few days I had exterminated all of them from the garden.—D. Melville, in Annals of Scottish Natural History, January, 1893, pp. 41–42.

In the month of February half a ton of one-and-a-half inch drain tiles were laid down separately throughout the plantations and a teaspoonful of oatmeal was placed in each, which was soon discovered and eaten by the mice. Phosphorus paste was then added to the meal and latterly small quantities of arsenic. The plan succeeded perfectly, and in a very short time they were all destroyed.—Sir Robert Menzies, Rannock, Perthshire, Scotland.

A mixture of four-fifths flour and one-fifth arsenic is introduced by the aid of a small palette knife into the middle of a drain pipe with an internal diameter of about 3 centimeters (1¼ inches), and this pipe is then put near the holes of the mice.—Recommended by the French Minister of Agriculture in a letter to the British Vole Commission of 1892.

I shell out pumpkin seed, grind it into meal, and mix with strychnine. This is put into a tomato or corn can, the sides bent flat, so that no other animal can get at the meal, and the can then laid on the side. It is a great success.—Method used by Fred. Noerenberg, Cascade Springs, S. Dak.

FUMIGATION.

Generally speaking, the various methods of fumigation for destroying field mice are unsuccessful. Nearly all the species have numerous burrows, and it is difficult to determine the occupied ones. To insure success, therefore, all the burrows must be fumigated, and the amount of labor and material involved makes the methods too expensive. However, occasionally carbon bisulphid may be used to advantage, especially with pine mice. A little of the liquid is poured upon a piece of rag or other absorbent material and this pushed into the burrow, which at once should be closed with soil to confine the gas.

MICRO-ORGANISMS.

The efforts of Löeffler, Danysz, Mereshkowski, and other European bacteriologists to destroy field mice by means of infectious diseases have been partially successful, but as yet no disease appears to have been found that is really contagious. As long, therefore, as infection can be effected only by direct inoculation or through the food, the methods have little, if any, advantages over ordinary poisons.

The Biological Survey, cooperating with the Bureau of Animal Industry, is engaged in experiments with various micro-organisms for destroying field mice and other rodents, and practical results along these lines may yet be reached.

RECOMMENDATIONS TO FARMERS.

When conditions are unusually favorable for an increase of voles, the farmer should put forth all possible efforts to repress them. With cooperation among the farmers of a district serious losses may readily be prevented. The danger lurks outside of cultivated areas and in the swamps, forests, and waste places along fence rows and small brooks that harbor weeds and underbrush. It is by giving attention to these and by reducing to a minimum the extent of shelter for mice that the farmer can most successfully protect his crops.

A second important consideration is the protection of animals and birds that prey upon field mice. The farmer should by all means acquaint himself with the food habits of the various species of wild animals of his vicinity, to the end that he may distinguish friend from foe. Every farmer can do much in his community to help form an enlightened sentiment in favor of beneficial birds, mammals, and other animals.

PREVENTION OF INJURY TO ORCHARDS AND NURSERIES.

Injury to orchards and nurseries by field mice may generally be prevented by forethought and the exercise of ordinary care. Of first importance, always, is clean tillage. No grass or weeds should be left in or near the nursery. So well is this understood by the majority of experienced nurserymen that by clean tillage they secure practical immunity from the ravages of mice except in winters of deep and long-lying snow. If grass and weeds are destroyed in fence corners and waste lands near the nursery, complete immunity from mice ravages can be depended upon even in winters of deep snow.

Unfortunately, nurserymen can not control the lands which environ their trees, and when snow falls to a considerable depth prompt measures are sometimes necessary to keep mice from destroying them.

This can be accomplished most readily by dragging a heavy log or stick of timber several times around each block of trees, packing the snow so firmly that mice can not tunnel under it. If this precaution is taken promptly after the first snow fall, subsequent falls will require but little attention. Some nurserymen plow furrows on both sides of the trees, throwing up the soil in a ridge along the rows; but the expedient is of doubtful utility.

Much of what has been said about the nursery will apply as well to young orchards. Clean cultivation is equally important, and under no circumstances should matted grass be allowed around the trunks of trees or litter be permitted to accumulate in the orchard or along its borders. In case of heavy snows, dragging should be resorted to or the snow stamped down carefully around each tree.

In the absence of snow, a cleared space of about 18 inches radius about the trunk of each tree is enough to prevent damage. The surface of the cleared space should be as smooth as possible, as even clods of earth may afford shelter for mice.

If any part of the orchard is so located as to be subject to snowdrifts and mice are abundant in the vicinity, tree protectors should be used. These may be had of dealers for 60 to 75 cents per hundred or they may be made by the farmer. Those offered for sale are usually wood veneers of some sort. In California the wood of a yucca (*Yucca brevifolia*) is utilized for the purpose. Strips of wire cloth make excellent protectors, and tarred paper is a favorite with some horticulturists. The wire cloth or paper is cut into strips about 7 inches wide and at least 15 inches long. A strip is secured around each tree with wire or cord. Tarred paper should never be used on very young trees, and when used on others should not be left in place during the summer, since it may injure the growing tree.

Various paints and washes have been recommended to prevent attacks of mice and rabbits in orchards. The majority of these are without merit and some of them are liable to kill young trees. Some of the washes require renewal after every hard rain. In experiments with a wash of whale-oil soap, crude carbolic acid, and water, for apple trees, it was found that in about forty-eight hours the carbolic acid had so far evaporated that mice renewed their work upon the bark. Blood and grease, said to give immunity from rabbit attacks, would invite the attacks of field mice.

Reports recently received by the Biological Survey seem to indicate that the ordinary lime-and-sulphur wash, recommended for the winter spraying of trees to destroy the San Jose scale, is an effective preventive of the attacks of both mice and rabbits. Personal observations during the winter of 1906–7 indicate that this claim is well founded. Several correspondents state that they have tried the wash successfully, and the matter is worth further investigation. The wash is very cheap (from 1 to 2 cents a gallon when prepared in 45 to 50 gallon quantities) and is easily applied to the trunks of trees either in the form of a spray or by the use of a brush. One thorough application in November would probably be effective for the entire winter. The ingredients of the wash are 20 pounds of unslaked lime, 15 pounds flowers of sulphur, and water to make 45 to 50 gallons. The mixture should be boiled in an iron kettle at least an hour and applied to the trees while warm.[a]

Winter mulching of trees is dangerous, unless the neighborhood is known to be free from mice. Mulch containing straw may be placed in the orchard in spring, but it should be removed before the approach of cold weather. Fine, thoroughly rotted manure may be used in the orchard with but little danger. Lime or ashes about the trunks of trees has some value in keeping off mice, but clean cultivation is equally or more effective.

REMEDIES FOR INJURED TREES.

When trees are girdled by mice, portions of the inner bark (cambium layer) are often left, partly covering the hard wood below. If sunlight and wind have free access to the injury, the remaining bark dries up and the tree dies. If light and air are excluded, new bark will form and the wound quickly heal over. To facilitate the healing process, it is important that wounds be covered as soon as possible. As a covering for wounded trees, wax, paint, strips of cloth, clay, and cow dung have been recommended, but none of them has any advantages over fresh, loose soil. Unless the ground is frozen, this is always available and easily applied to wounds near the ground. All that is needed is to mound up the soil about the trunk of the tree high enough to cover the wound. Allowance should be made for settling of the soil, and the covering should remain during the entire summer. Plate VIII shows trees 5 inches in diameter which were completely girdled by mice in December, 1903. Soil was heaped about the trunks in January, 1904, and allowed to remain until May, 1905, when it was removed and the photographs made. New bark completely covered the wounds, leaving slight visible scars.

If large fruit trees are injured high up, as sometimes happens when snow is drifted about them and mounding up the soil is impracticable, there are other means of saving them. If the injury is not too extensive, grafting wax should be applied to the wounds and the tree wrapped with strips of cloth. If, however, the cambium be eaten through over considerable surface, bridge grafting may be resorted to.

Bridge grafting is not difficult. It consists in bridging over the girdle of eaten bark by means of scions or small twigs of the same kind of tree. The injured bark at the top and bottom of the wound should be cut back to live, healthy tissue and small clefts or notches made in it. The ends of the scions are then cut to fit these notches, the scion itself being left slightly longer than the span of the injury, so that they may be sprung into position and held firmly. The cambium layer of tree and scion should meet over as much surface as possible. Some operators use a chisel to cut the notches and a small nail or tack at each end to hold the scion in position. The last step is to cover all exposed cut surfaces with grafting wax or to bind all with waxed cloth so as to exclude air until the scions are firmly united with the tree.

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[a] See Yearbook U. S. Dept. of Agriculture, 1906, pp. 429–446, Lime-sulphur Washes for the San Jose Scale.

If young orchard trees are but slightly injured a covering of grafting wax may be applied with good results, though a covering of soil is equally effective. The usefulness of paints for damaged trees depends both upon the stage of growth and the composition of the paints. Some are said to kill trees if applied in the spring. Coal tar will do the same, as the writer learned by costly experiment. Pine tar has been highly recommended for wounded trees, but it has been known to kill young peach trees to which it was applied to keep away mice.

For nursery stock badly injured by mice there is no remedy. When the injury is slight the wounds may be covered with wax or soil and will heal over in a season, delaying sale for a year. This applies to both deciduous trees and evergreens. In the case of young trees, when the injury is considerable the tops may be cut out and new ones grown more quickly than fresh stock, but this is possible only when the wounds are well above the original graft. In the case of valuable or rare sorts bridge grafting may be resorted to, but for ordinary stock it is cheaper to pull up the injured trees and grow new ones.

SUMMARY.

Field mice, because of their small size, secretive habits, and great fecundity, often become a menace to farm and orchard crops in many parts of the country. In the Old World, as well as in America, corrective measures begun after a plague of the animals is in full progress have usually proved ineffectual. Preventive measures, if carefully carried out, are sufficient to avoid serious losses.

Among the more important measures for preventing ravages by field mice are the following:

1. Protection of the natural enemies of field mice, particularly owls, most hawks, shrikes, snakes, skunks, badgers, and most species of weasels.
2. Elimination of the breeding grounds of field mice by draining swamps and cleaning waste places that afford the animals harborage.
3. Periodic plowing of grass and other lands for the rotation of crops.
4. Clean cultivation of corn and all other crops, and especially of orchards and nurseries.

5. Clean mowing of grass lands and permanent meadows, so that no old grass is left over winter.
6. Careful burning about orchards and gardens of weeds, trash, and litter of all kinds that may serve the animals for winter shelter.
7. When necessary, the burning of dead grass in meadows and pastures. This, however, should not be delayed till late spring, when ground birds are nesting.

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U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF BIOLOGICAL SURVEY—BULLETIN No. 32

C. HART MERRIAM, *Chief*

FOOD HABITS OF THE GROSBEAKS

BY

W. L. McATEE

ASSISTANT, BIOLOGICAL SURVEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., November 1, 1907.

SIR: I have the honor to transmit herewith for publication as Bulletin No. 32 of the Biological Survey a report on the food habits of the grosbeaks, by W. L. McAtee. The grosbeaks are a small group of finches, hitherto more widely appreciated for their bright plumage, sweet song, and attractiveness as cage birds than for their services to agriculture. These are here shown to be of such character as to entitle the several members of the group to every consideration at the hands of the farmer.

The illustrations which accompany this paper are considered essential to a proper understanding of the text.

Respectfully,
H. W. HENSHAW,
Acting Chief Biological Survey.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

Page.
Introduction 5
Cardinal 5
  Distribution and habits 5
  Economic relations 6
    Vegetable food 7
    Animal food 13
    Mineral matter 23
    Nestlings 23
    Summary 24
  List of seeds, fruits, and invertebrates eaten 25
Gray grosbeak 28
  Appearance, distribution, and habits 28
  Economic relations 28
    Vegetable food 28
    Animal food 29
    Mineral matter 31
    Summary 31
  List of seeds and invertebrates eaten 32
Rose-breasted grosbeak 33
  Appearance, distribution, and habits 33
  Economic relations 34
    Vegetable food 34
    Animal food 42
    Mineral matter 55
    Nestlings 55
    Summary 57
  List of seeds, fruits, other vegetable substances, and invertebrates eaten 58
Black-headed grosbeak 60
  Appearance, distribution, and habits 60
  Economic relations 60
    Vegetable food 61
    Animal food 68
    Mineral matter 74
    Nestlings 74
    Summary 75
  List of seeds, fruits, and invertebrates eaten 76
Blue grosbeak 78
  Appearance, distribution, and habits 78
  Economic relations 78
    Vegetable food 79
    Animal food 81
    Mineral matter 83
    Young 84
    Summary 84
  List of seeds, fruits, and invertebrates eaten 85
Relations of grosbeaks and other birds to parasitic insects 86
General conclusion 89

ILLUSTRATIONS.

PLATES.

Page.
PLATE I. Cardinal and gray grosbeaks .... Frontispiece
II. Seeds and fruits eaten by grosbeaks 10
III. Black-headed and rose-breasted grosbeaks 34
IV. Blue grosbeaks 78

TEXT FIGURES.

FIG. 1. Seeds of smartweed 11
2. Seeds of cockspur grass 12
3. Seeds of blue vervain 12
4. Seeds of ribgrass 12
5. Seeds of corn gromwell 13
6. Seeds of ragweed 13
7. Caterpillar hunter 14
8. Bollworm or corn-ear worm 16
9. Cotton cut-worm 16
10. Zebra caterpillar 17
11. Harvest-fly 17
12. Billbug 19
13. Figeater 19
14. Rose-beetle 20
15. A flower eating scarabæid 20
16. Locust leaf-miner 21
17. Seeds of yellow foxtail 29
18. Seeds of rough tumbleweed 29
19. Cotton boll weevil 30
20. Cotton worm 31
21. Seeds of black bindweed 41
22. Pine buprestid 44
23. Seed corn scarabæid 45
24. Plum curculio 46
25. Potato beetle 47
26. Spotted cucumber-beetle 49
27. Fall cankerworm 51
28. Army worm 51
29. Orchard tent-caterpillar 52
30. Gipsy moth 52
31. Brown-tail moth 53
32. Buffalo tree-hopper 54
33. Australian ladybird 69
34. Codling moth 72
35. Spring cankerworm 73
36. Black olive scale 73
37. Seeds of green foxtail 81
38. Purslane caterpillar 82
39. Lesser migatory locust 83
40. Coral-winged locust 84

FOOD HABITS OF THE GROSBEAKS.

INTRODUCTION.

Two distinct groups of finches or sparrows are commonly known as grosbeaks. One of these, which includes the pine and evening grosbeaks, is of little practical importance, since its members breed and pass most of their lives in mountainous regions, or in the northern parts of North America. The other group includes the cardinal, gray, rose-breasted, black-headed, and blue grosbeaks, which spend either the summer or the entire year within agricultural regions of the United States. Hence their food habits are of considerable importance to the farmer.

The members of the first-named group may be dismissed with the statement that during the period when they occur in non-mountainous districts their food consists largely of wild seeds and berries. Apparently the best relished are those of mountain ash, choke cherry, box elder, white ash, and maple, and of spruce, red cedar, and other coniferous trees. The food habits of the second group are treated in detail in the following pages.

CARDINAL.

(*Cardinalis cardinalis.* Plate I, Frontispiece.)

DISTRIBUTION AND HABITS.

The brilliant and easily recognized cardinal ranges over much of North America. It occurs from southernmost Mexico and northern Central America north to New York, Ontario, and northern Iowa, and west to central Kansas, Arizona, and Lower California. In parts of this area the size and color have been so modified by climatic and other causes that 12 varieties or subspecies are distinguishable. Five of these reside in the United States, and while they bear no distinctive vernacular names, the species as a whole is well supplied, being variously known as cardinal grosbeak or cardinal, Virginia nightingale, redbird, and also as the crested or topknot redbird, in distinction from the summer redbird or tanager.

The cardinal is resident wherever found; that is, the neighborhood where the bird rears its young is its home throughout the year. It is most abundant perhaps in the Southern States, where almost universally it is known as the redbird, and is often kept as a household pet. Affection for the bird, however, is not confined to the South, for its loud, ringing song, bright plumage, and vivacious manner make it a favorite wherever it lives. When winter's snows cover its favorite feeding grounds the redbird becomes bolder and seeks its fare about sheds and barns and even among the horses' feet. Spring returning, its natural food supplies are once more available, and then the cardinal mostly frequents hedges, fence rows, and brushy thickets. The cardinal is one of the few birds which sings throughout the year, although, of course, its songs are rendered more frequently and in greater perfection during the breeding season.

The nest is loosely built and generally is placed in a bush or vine, often in the densest tangles; in it three or four speckled eggs are laid. The first set of eggs usually is completed in May, but the second clutch is sometimes postponed until late summer. The cardinal is very sensitive to any interference in its domestic affairs, and unfinished nests and even those containing full complements of eggs are deserted upon slight provocation. Hence one who would have cardinals for neighbors must see to it that the birds' privacy is undisturbed. The male redbird is a model parent, rushing to the defense of the nest in every emergency, doing a great share of the feeding and otherwise caring for the young. The first birds of the year usually begin to shift for themselves about midsummer.

The nest of the redbird is often within a few feet of the ground, and this circumstance leads to the destruction of many sets of eggs and broods of young by snakes, cats, and prowling wild mammals. Hence the bird needs protection, and when this is afforded it easily maintains its numbers.

ECONOMIC RELATIONS.

As mentioned above, the cardinal has ever been a favorite cage bird, and in some localities in the south great numbers have been trapped and sold into captivity. In times past it has suffered greatly also from the persecution of millinery collectors. Despite legal enactments against the killing of birds for hat gear, even yet the practice has by no means ceased, and among other useful birds the cardinal still suffers to a greater or less degree. In the District of Columbia cardinals were noted on hats as late as 1906.

The extent of the former traffic in wild birds for cage purposes was remarkable. "Thousands of mockingbirds, cardinals, indigo birds, and other bright-plumaged species were formerly trapped for sale in this country and abroad, and so assiduously did the bird trappers ply their vocation that in some localities these species were almost exterminated."[a]

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[a] T. S. Palmer, Yearbook, Department of Agriculture, 1905, pp. 557–558.

Referring to the cardinal in particular. Nuttall[a] makes the statement:

> So highly were these birds esteemed for their melody that, according to Gemelli Carreri [who wrote in 1699], the Spaniards of Havana, in a time of public distress and scarcity, bought so many of these birds * * * that the sum expended, at ten dollars apiece, amounted to no less that 18,060 dollars.

The liking of the islanders for this bird has suffered no abatement in later days, according to W. E. D. Scott,[b] who wrote in 1889: "The cardinal is in great demand as a pet by the Cubans, and on that account is a regular feature of the auction rooms, being supplied from the northern keys and the mainland" [of Florida]. However, recent laws, while they have not wholly put an end to these baneful practices, have greatly restricted them, and the cardinal, along with other insectivorous birds, is nowadays comparatively well protected.

That from an economic standpoint the bird deserves complete protection, the following discussion of its food habits will make clear. Four hundred and ninety-eight stomachs of this species have been examined. They were collected during every month of the year and in twenty States, the District of Columbia, and Ontario. But for the fact that this material is unevenly distributed, seasonally and geographically, the results obtained from its examination would be perfectly satisfactory. As it is, Texas is much more completely represented than any other State, and May than any month, while the feeding habits for June and October are known only from examination of a very small number of stomachs. These conditions necessarily affect the results, but in view of the large number of stomachs, it is believed that a fairly correct idea of the normal food habits of the species has been obtained. As a result of our investigations it appears that, for each of the twelve months, the cardinal averages 28.99 percent of animal food and 71.01 percent of vegetable. The maximum percentage of animal food for any one month is 78.4, being the average for 123 birds taken in May. The minimum is 4.9 for 41 birds in January.

VEGETABLE FOOD.

It is generally stated that the cardinal is largely, if not entirely, vegetarian. While this statement is perhaps too strong, the result of the present investigation leaves no doubt that vegetable products compose the redbird's main subsistence at nearly all times of the year. In only one month do they constitute less than half the food, while for the entire year they average 71.01 percent. Grain amounts to 8.73 percent; wild fruit, only the seeds of which are usually eaten, composes 24.17 percent; weed and other seeds 36.38 percent, and miscellaneous vegetable substances 1.73 percent.

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[a] Manual of Ornithology, The Land Birds, 1832, p. 525.

[b] Auk. VI, 1889, p. 324, quoting Atkins.

GRAIN.

A little more than 7.1 out of a total of 8.73 percent of grain eaten by the cardinal grosbeak is corn, while other cereals, including wheat, oats, sorghum, and rice, constitute the remaining 1.62 percent. Eleven birds had eaten oats, 4 wheat, 2 sorghum, and 1 rice, but so trifling is the percentage of these grains that practically no damage is done except under very unusual conditions, such as the concentration of a great number of redbirds in a small area; but this is improbable, because the redbird usually is nongregarious.

In regard to corn, however, which was eaten by 68 of the birds examined, more extended consideration is desirable. The redbird's fondness for Indian corn is noted by many writers, but extensive injury to the crop is charged by very few. Leverett M. Loomis,[a] in writing of the birds of South Carolina, says the cardinal is "held in considerable ill repute because of its alleged depredations on newly planted corn." A correspondent in Alabama writes that the redbird is injurious to corn in the roasting-ear stage, and that it also "pulls the corn in the spring when it is just up with two or three leaves." Little direct evidence concerning the redbird's depredations on corn is derivable from our examinations, because none of the birds studied were collected in newly planted fields or where corn was exposed to attack. It should be stated, however, that during March, April, and May, which months cover the planting seasons from southernmost United States to Canada, less than the average amount of corn is consumed. Corn constitutes a greater proportion of the food in January than in any other month, and practically all eaten at this season is waste. So also in November and December, when corn makes up 4 and 7 percent, respectively. Waste grain is often eaten in spring and even in midsummer, according to observations by the writer.

The cardinal is said to bore into grain stacks and also to visit corncribs in winter, but probably it does so only under stress of unusual circumstances, as deep snow, and in all likelihood the damage is trivial. Lining the crib with medium-meshed wire netting, which can be done at small cost, will prevent access by the birds, and at the same time guard against attacks of rodents and poultry, while in no way interfering with the necessary ventilation.

Considerable corn is eaten by the redbird during June, July, and August, and a portion of this may be pilfered from the standing crop. At this season, however, the birds are scattered, and it is not likely that much damage results in any one locality.

From the above it appears that present evidence does not suffice to determine the exact relation of the redbird to the corn crop, although, so far as it goes, it is in the bird's favor. To summarize:

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[a] Auk. VII, 1890, p. 125.

Very few complaints have been made of attacks on corn by the redbird. Though this evidence is negative, it possesses some weight, since accusations against serious grain pests are always numerous and emphatic. The greatest proportion of corn is eaten in winter, hence is waste; and finally, the redbird does not flock habitually, and never at a season when corn is exposed to attack. For these reasons it may be concluded that the cardinal's depredations on corn are of little consequence.

WILD FRUIT.

Wild fruit, or rather the seeds of wild fruit, pulp being present in very few stomachs, was eaten by 312 of the redbirds examined, and, with the exception of weed seeds, is the largest item of the vegetable food. Of all fruits wild grapes are most important. From November to April their seeds constitute 17 percent of the cardinal's fare. They were eaten by 178 birds and in every month, forming on the average 11.9 percent of the subsistence throughout the year. Three species, the summer grape (*Vitis aestivalis*, Pl. II, fig. 8), the frost grape (*V. cordifolia*), and the bullace or southern fox grape (*V. rotundifolia*) were identified, and there is no doubt that the redbird feeds upon all kinds of wild grapes growing within its range. Although wild grapes are such favorite food, they seldom are swallowed whole, only one or two entire grapes being found in the stomachs. Further, very few entire seeds are swallowed. The seeds are generally crushed and ground by the powerful beak into such small bits that their identification is very difficult.

The presence of great numbers of fruit seeds with little or no pulp is accounted for by well-known habits of the bird. It searches continually among leaves and rubbish on the ground, where it secures many of the seeds and shriveled fruits. It also gathers dried berries from the vines in winter.

The fruits of various dogwoods rank next to grapes in the redbird's regimen. They were eaten by 52 birds and constitute 3.97 percent of the total food examined. Rough-leaved (Pl. II, fig. 6) and flowering dogwood (Pl. II, fig. 5) seeds were identified. Any one familiar with the intense bitterness of these fruits will admit that the cardinal possesses considerable individuality of taste.

All fruits united, other than cornel berries and grapes, form 8.3 percent of the annual food. Most important among them are blackberries and raspberries, which were eaten by 34 birds. Mulberries were eaten by 31, and hackberries by 23 redbirds. Among the latter fruits two species were identified—the common hackberry or sugar berry (*Celtis occidentalis*, Pl. II, fig. 2) and the southern hackberry (*C. mississippiensis*). The last named was eaten by nearly 20 cardinals collected in one locality in Texas. Smilax seeds, identified as of the bristly or bamboo greenbrier (*Smilax bona-nox*), which are almost as hard as wood, were taken by 2 individuals. It would be well for humankind if more birds were fond of the seeds of these detestable vines. One cardinal ate seeds of Solomon's seal (*Polygonatum biflorum*).

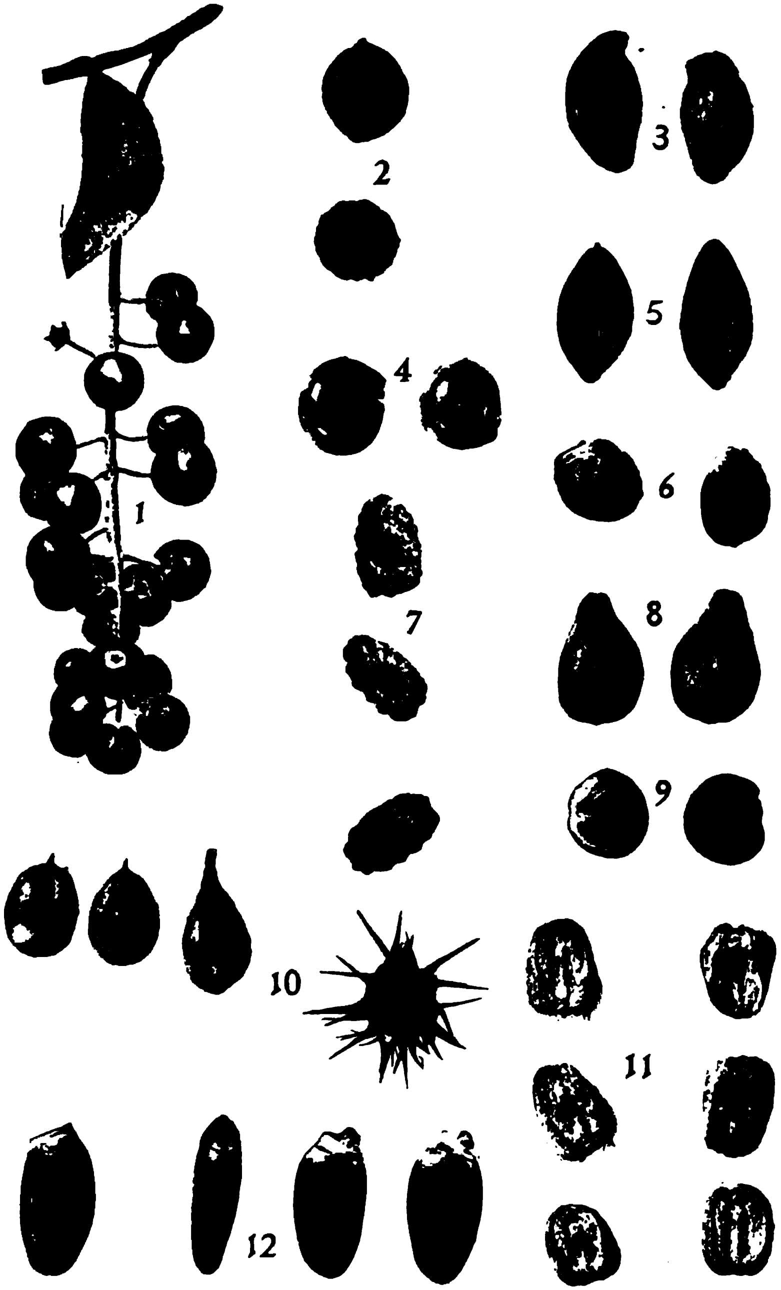
Cherries also are on the redbird's bill of fare. One correspondent states that redbirds filch cultivated varieties, but as none appeared in any of the stomachs examined, the occurrence probably is exceptional. Chokecherries are consumed, however, and Dr. A. K. Fisher has observed a cardinal eating the fruit of a seedling cherry (*Prunus avium*).

Wilson says cardinals feed upon the seeds of apples, but this habit also must be rare; in the course of the present investigation no cultivated fruit of any kind was found.

Six cardinals devoured blueberries (*Vaccinium* spp. including *V. virgatum*), three ate the aromatic berries of spice bush (*Lindera benzoin*), and 6 took the purple fruit of the pokeberry (*Phytolacca decandra*, Pl. II, fig. 4). The seeds of the succulent fruit of the prickly pear (*Opuntia opuntia*, Pl. II, fig. 9) were found in the stomachs of 3 cardinals, taken near the District of Columbia, where the plant abounds on the rocky banks of the upper Potomac. Six redbirds fed upon the drupes of sumac, including those of the poison ivy (*Rhus radicans*) and of the skunk bush (*Rhus trilobata*). These fruits are sometimes eagerly sought. The writer once in winter observed a scattering flock of 50 or more redbirds feeding on the berries of scarlet sumac.

The elderberry, which is so relished by the rose-breasted grosbeak, is rather neglected by the cardinal, only 2 having selected it. Two also ate ground cherries and black haws, while but 1 stomach contained rose hips, though the bird has often been observed devouring these fruits. Juneberries (*Amelanchier canadensis*, Pl. II, fig. 3) and others of the same genus are eaten; both holly (*Ilex opaca*) and inkberry (*I. glabra*) are occasionally secured, as well as red cedar berries (*Juniperus virginiana*), the fruit of the knockaway tree (*Ehretia elliptica*), and red haws (*Cratægus* sp.). In a stomach collected in South Carolina in January were more than 12 seeds of the berry of the passion flower (*Passiflora incarnata*). To the above list of fruits eaten by the cardinal, various authors add the wahoo berry (*Euonymus* sp.), Mexican mulberry (*Callicarpa americana*), and drupes of the cabbage palmetto (*Sabal palmetto*) and saw palmetto (*Serenoa serrulata*).

Among many items of vegetable food to be classed as miscellaneous are some of particular interest. Acorns were eaten by a few cardinals and one bird even selected a hickory nut. The strength of bill necessary to shear into such hard seeds may be imagined, and it



SEEDS AND FRUITS EATEN BY GROSBEAKS.

[1, Wild black cherry (*Prunus serotina*). 2, Hackberry (*Celtis occidentalis*). 3, Juneberry (*Amelanchier canadensis*). 4, Pokeberry (*Phytolacca decandra*). 5, Flowering dogwood (*Cornus florida*). 6, Rough-leaved dogwood (*Cornus asperifolia*). 7, Spiderwort (*Tradescantia virginiana*). 8, Summer grape (*Vitis æstivalis*). 9, Indian fig (*Opuntia opuntia*). 10, Bur grass (*Cenchrus tribuloides*). 11, Button weed (*Diodia teres*). 12, Milk thistle (*Mariana mariniana*). 1, Natural size; 2, 5, 9, 10 (bur), magnified twice; 6, 7, 8, 11, 12, magnified three times; 3, 4, 10 (seeds), magnified four times.]

is noteworthy that the cardinal appears to be the only one of the grosbeaks which uses its massive beak for the purpose for which it seems especially designed, namely, the cracking and grinding of hard seeds. The samaras of maple were found in a few stomachs, and in Florida Mr. C. J. Maynard[a] observed more than 20 cardinals feeding on the seeds of a single maple. The somewhat similar winged seeds of the tulip tree also serve as food, and, according to the experience of the writer, are a favorite winter diet of the redbird around Washington. Galls were eaten by 4 birds, and buds, which often have been stated to be especially sought after by grosbeaks, by only 2.

WEEDS.

The seeds of bindweeds, grasses, sedges, etc., form 36.38 percent of the entire food—more than half of the vegetable diet of the species. They were eaten by 361 of the birds examined, and range from 6 to 49 percent of the fare in different months, the greatest quantity being consumed in winter. The seeds of the various smartweeds (fig. 1) and bindweeds (fig. 21) are of most importance, having been consumed by 81 cardinals and constituting 5.57 percent of the annual food. Six species were identified, and it is probable that the seeds of all members of this large genus are eaten indiscriminately. They are among the commonest and worst weeds of both dooryards and cultivated fields. Besides being notorious crop chokers and seed adulterants, smartweeds are the main support of the disastrous corn-root aphids before the latter are transferred to the corn by their ant guardians. Hence the cardinal's habit of devouring smartweed seeds is beneficial, not only in abating direct injury by these pernicious weeds but also in tending to diminish the number of aphids by destroying their most important host plants.

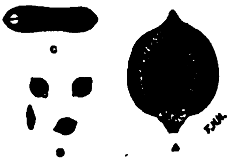


FIG. 1.—Seeds of smartweed (*Polygonum lapathifolium*), (From Hillman, Nevada Experiment Station.)

The seeds of foxtail grasses (figs. 17 and 37) are next in importance. Foxtail is only too well known for its keen competition with cultivated crops, and is to be classed among the most troublesome weeds. Its seeds compose 3.21 percent of the cardinal's food, 51 out of 498 birds examined having eaten them. Bur grass (*Cenchrus tribuloides*, Pl. II, fig. 10) should be mentioned here, as it is possible some of its seeds were wrongly classed with those of foxtail, the shelled kernels of which they greatly resemble. They have been positively identified in several stomachs. Henry Nehrling[b] says cardinals "are very fond of bur grass seeds or sand spurs * * * which are furnished with formidable spines. This grass is a very vile weed of the southern fields and the orange groves of Florida."

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[a] Birds of E. N. A., 1881, p. 109.

[b] Our Native Birds of Song and Beauty, II, 1896, p. 196.

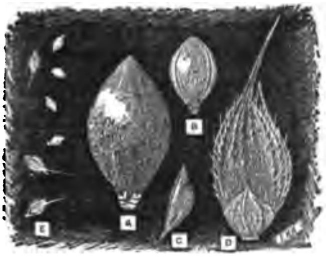

FIG. 2.—Seeds of cockspur grass (*Echinochloa crus-galli*). (From Hillman, Nevada Experiment Station.)

The seeds of other grasses, including cockspur grass (*Echinochloa crus-galli*, fig. 2), crab grass (*Syntherisma sanguinalis*), and allied species, which are well-known weeds, were fed upon by 31 redbirds, yard grass (*Eleusine indica*) by 31, and unidentified grasses by 22. Seeds of the nearly related sedges (*Carex* et al.) were devoured by 41 cardinals, those of vervians (*Verbena hastata*, fig. 3, and *V. urticæfolia*) by 25. Twenty-two birds ate seeds of the well-known ragweeds (fig. 6), and 39 those of various spurges.

Among the other weed seeds eaten in smaller quantities are those of dodder, a serious pest in grain crops; vetch, dock, sow thistle, plantains, including the detestable ribgrass (fig. 4); tumbleweed (fig. 18), sunflower, violets, geraniums, stargrass, spiny sida, corn gromwell (fig. 5), spiderwort (Pl. II, fig. 7), lamb's-quarters, chickweed, stick-tight, sorrel, button weed (Pl. II, fig. 11), and stick-seed. To this list W. D. Doan adds clover and partridge pea.[a] One plant in the above list, namely, buttonweed, is known also as alligator head in the South, where it is a bad weed in rice fields. It has been said that "as the seeds are about the color of the soil they are not easily seen and are not apt to be picked up by birds." This is a mistake, however, for these seeds are devoured by many kinds of birds, and some, as the bobwhite, eat large numbers of them.

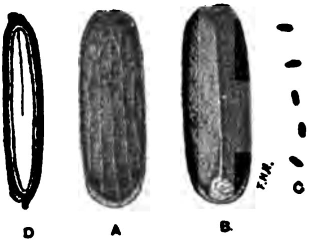

FIG. 3.—Seeds of blue vervain (*Verbena hastata*). (From Hillman, Nevada Experiment Station.)

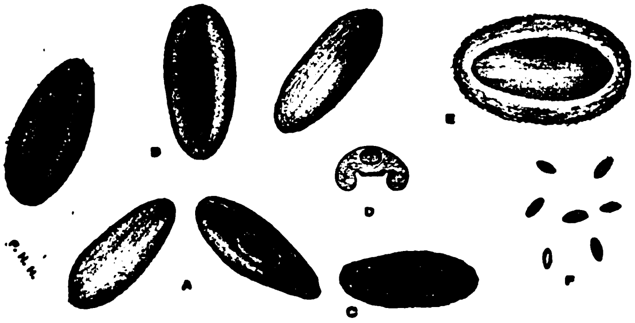

FIG. 4.—Seeds of ribgrass (*Plantago lanceolata*). (From Hillman, Nevada Experiment Station.)

After plants have seeded it is impossible for man appreciably to diminish the number of seeds. But this work is the peculiar function of seed-eating birds, and their great value to the farmer consists in the service they render in this direction. The warfare against seeds, so costly to him, is waged by the whole body of sparrows and other seed-eating birds year in and year out without cessation. Were it not for them the number of weeds would be vastly greater and the resulting damage correspondingly larger. How great this damage is will appear from the statement that the loss to the wheat interests of Minnesota from dockage, largely due to the presence of weed seed, is about $2,500,000 annually.[a] Moreover, conditions in Minnesota are not exceptional, and in every State the total annual loss from weed seeds is very great. So far, then, as farmers can protect and increase the number of weed-seed eating birds to that extent will they reap the benefit of increased service from these faithful servants. The redbird eats the seeds of many of the most harmful weeds, making more than a third of its subsistence upon them. Hence it occupies a very important place among the weed-destroying birds, and should be prized accordingly.

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[a] Bull. 3, Agr. Exp. Sta., W. Va., 1888, p. 74.

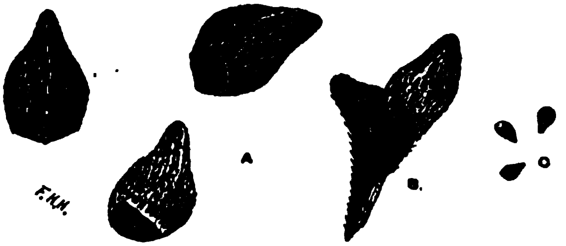

Fig. 5.—Seeds of corn gromwell (*Lithospermum arvense*). (From Hillman, Nevada Experiment Station.)

Animal Food.

Though in quantity much less than the vegetable food, the animal portion of the cardinal's diet is much more diverse and is comprised in no less than six of the natural classes. These are myriapods, centipedes, insects, spiders, bivalves, and univalves. Insects are vastly more important than the others and constitute 26.25 out of 28.99 percent, the total proportion of animal matter consumed. The percentage is apportioned among the orders of insects as follows: Wasps 0.92, bugs 3.72, butterflies (and caterpillars) 5.1, grasshoppers 6.42, and beetles 10.48.

Fig. 6.—Seeds of ragweed (*Ambrosia artemisiaefolia*). (From Hillman, Nevada Experiment Station.)

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[a] Bull. 95, Minn. Agr. Exp. Sta., 1906, p. 195.

The last-named group includes two mainly beneficial families, the ground beetles (Carabidæ) and the fireflies (Lampyridæ). Since the destruction of these beetles by the cardinal tends to neutralize the good done in other ways, it is important to understand thoroughly the nature of the bird's relation to them. Among the most beneficial of beetles are the caterpillar hunters (*Calosoma*, fig. 7), which ascend trees in quest of their prey, a rare habit among ground beetles. Thus these beetles attack caterpillars in a way others are unable to do. Two cardinals ate beetles of this genus. Another large carabid (*Pasimachus*), an enemy of grasshoppers and the army worm, was eaten by one redbird. Others devoured include *Harpalus caliginosus*, which is the bulky black beetle often seen feeding on the flowers of ragweed and which is evidently not entirely predaceous, and a larva of the nearly related beetle *Dicaelus*. Three birds captured individuals of the medium-sized but very hard *Scarites subterraneus*, which generally hides under stones by day. Specimens of two species of *Anisodactylus* and one beautiful blue *Callida* also were eaten. In all 34 redbirds fed upon beetles of this useful family, but each must have eaten sparingly, for the beetles compose but 0.75 percent of the entire food, an amount too small to be reckoned against the consumer of more than 8 times that quantity of grasshoppers, in addition to many other injurious insects.

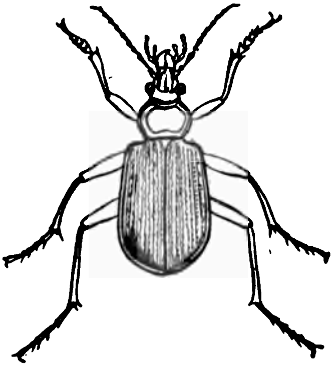

Fig. 7—Caterpillar hunter (*Calosoma scrutator*). (From Riley.)

Fireflies were eaten by only 4 cardinals, one of the birds obtaining the common black and yellow soldier beetle (*Chauliognathus marginatus*), which commonly feeds on the pollen of midsummer blossoms, and another, one of the small black fireflies (*Telephorus pusillus*), the larvæ of which are enemies of some common agricultural pests. Fireflies are eaten in such moderate measure that it is impracticable to assign them a percent, and we may conclude, so far as the present data go, that the cardinal does no appreciable injury to this group of insects.

The wasps and similar insects (Hymenoptera) include among their number many beneficial parasitic species, and for that reason their status as food of the redbird must be looked into. Fifty-nine of the grosbeaks examined had eaten these insects, but they amount to only 0.92 percent of the total food. None were positively identified as parasitic species, while some injurious forms were distinguished. Eleven cardinals ate ants, including the harvesting ants (*Pogonomyrmex*) and the small reddish *Lasius*, which foster plant lice, notably the corn root aphids. One grosbeak ate a sawfly, which also is an insect of unsavory reputation.

The cardinal is frequently alluded to in ornithological literature as preying upon bees. Peter Kalm published the first of these statements in 1770, and the later ones were probably suggested by, if not copied from, his. Wilson (1831), Nuttall (1832), and later authors reiterate the charge, though the context does not show that any of them knew of the matter at first hand. It is quite possible that, so far as this particular trait is concerned, the cardinal has been confounded with the similarly colored but otherwise very different summer redbird, which is well known to prey upon bees. At any rate, it is significant that the present examination did not reveal a single bee among the insect food of the redbirds. On the whole, the cardinal shows no great relish for Hymenoptera, and among the species eaten those injurious to man and the less valuable kinds predominate.

Among other possibly beneficial insects, the redbirds had eaten an assassin bug and a remarkable predaceous neuropteron (*Mantispa brunnea*), also a nymphal and an adult dragon-fly. The latter creatures probably do as much harm in destroying young fish as good in preying upon insects. At most, not more than 2 percent, probably much less, of the cardinal's food consists of useful insects, while 12 times as much consists of injurious species, the destruction of which is a benefit.

One of the most important constituents of the major proportion is Lepidoptera. They compose 5.08 percent of the annual subsistence, amounting, however, in May to 26.71 percent. The adults taken consist of 5 moths and 1 butterfly, which together make up 0.17 percent of the food. Caterpillars are much more relished and 137 redbirds fed upon them, sometimes obtaining from 7 to 18 each. The cotton worm (*Alabama argillacea*, fig. 20), which formerly was a serious pest and which even now spoils a late-planted crop, was eaten by 3 cardinals. There is evidence that the bird habitually feeds upon this insect, and as early as 1885 C. V. Riley remarked[a] that "birds are of incalculable benefit" in combating the cotton worm, and the cardinal is one of those which prey upon it more or less persistently.

A second cotton pest, the bollworm (*Heliothis obsoleta*, fig. 8), which is familiar also as the corn ear-worm, is occasionally devoured, and a third, the cotton cutworm (*Prodenia ornithogalli*, fig. 9) is greatly relished. Ninety-six of the latter were eaten by 31 cardinals from the Texas cotton fields. The destruction of cotton insects by the redbird is important, since the bird is numerous in the cotton region and feeds upon the worst enemies of the plant.

The sphinx caterpillars, so many of which are injurious to cultivated plants, were eaten by 20 redbirds. The species identified are the laurel sphinx (*Sphinx kalmiæ*) and the purslane sphinx (*Deilephila lineata*, fig. 38), the latter being a general feeder and attacking several garden and field crops. Measuring worms were eaten by 2 cardinals, the zebra caterpillar (fig. 10) of the cabbage by 1, while 2 secured chrysalides of the notorious codling moth. It thus appears that the lepidopterous food of this grosbeak contains a number of serious pests, and the bird accomplishes much good by destroying them.

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[a] Fourth Ann. Rep. U. S. Ent. Comm. 1885, p. 88.

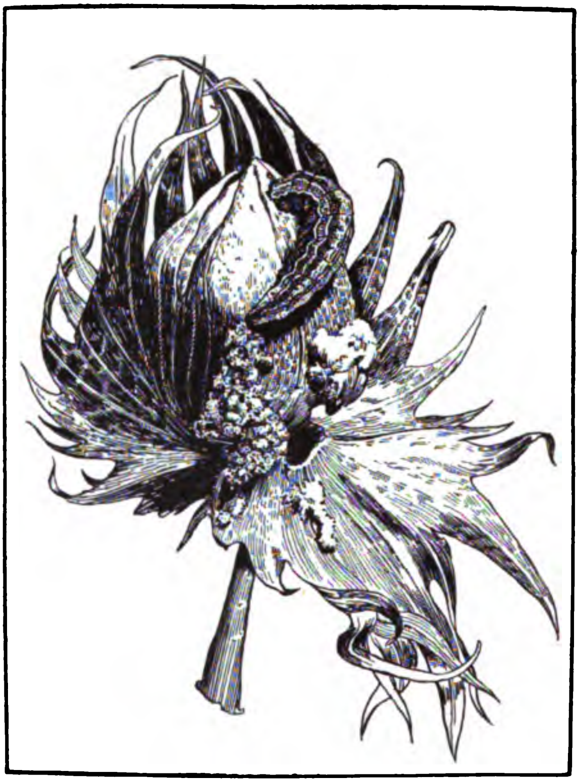

Fig. 8.—Bollworm or corn-ear worm (*Heliothis obsoleta*). (From Quaintance, Bureau of Entomology.)

A somewhat larger number of cardinals than ate caterpillars preyed upon grasshoppers, and these insects form a correspondingly larger proportion of the food, namely 6.43 percent. Crickets and long and short horned locusts were eaten and a decided taste for the eggs of katydids is shown, they being consumed by 21 redbirds. Among the short-horned grasshoppers the small shield-back grouse locusts were taken, and also the lesser migratory locusts (*Melanoplus atlanis*, fig. 39), which during the invasions of the Rocky Mountain grasshopper was second only in importance to that formidable insect. The cardinal did its share in repelling the locust hosts in the seventies, Mr. Aughey, of Nebraska, finding more than 20 locusts per bird during his examinations. It is certain that the redbird's aid in restricting the less conspicuous pests of the present day is no less valuable.

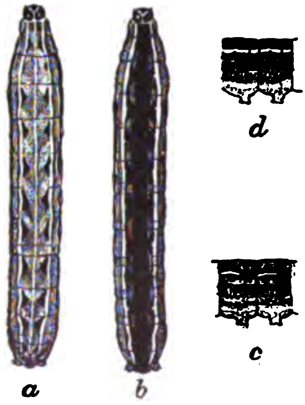

Fig. 9.—Cotton cutworm (*Prodenia ornithogalli*). (From Chittenden, Bureau of Entomology.)

Other insects bearing the name "locusts," but not at all closely related to the grasshoppers, belong to the order Hemiptera, which furnishes 3.72 percent of the cardinal's subsistence. These dogday locusts, harvest or jarflies, which injure the twigs of trees, are, on account of their loud, vibrating song, among the best-known insects.

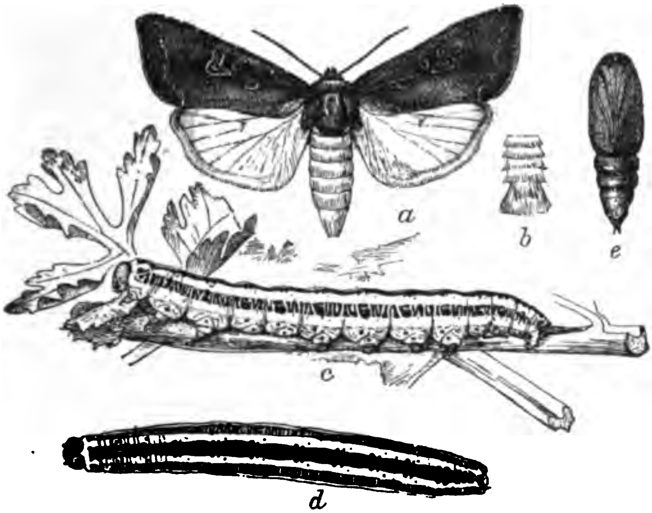

FIG. 10.—Zebra caterpillar (*Mamestra picta*). (From Chittenden, Bureau of Entomology.)

Their great size would seem to prevent most birds from capturing them, but 9 of the redbirds examined had accomplished the feat. The common harvest fly (*Cicada tibicen*, fig. 11) was identified from two stomachs, and according to A. W. Butler[a] the seventeen-year locust (*Tibicen septendecim*) also is eaten by the redbird.

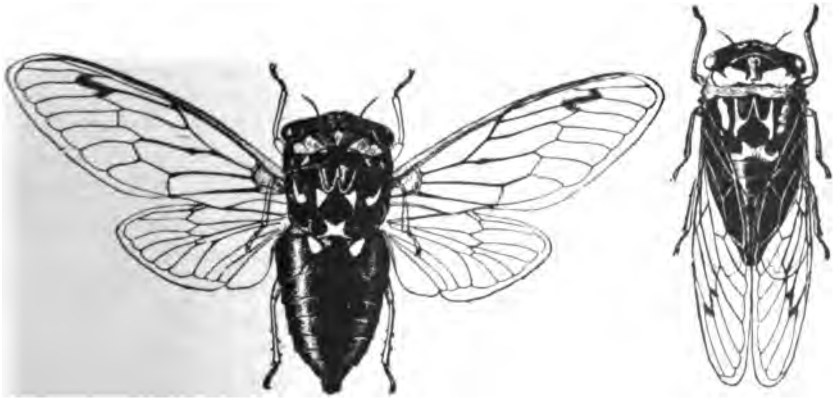

FIG. 11.—Harvest fly (*Cicada tibicen*). (From Lugger, Minnesota Experiment Station.)

Several insects of this order are miniatures of the cicadas, such as the jumping plant-lice (Psyllidæ) and leaf-hoppers (Tettigonidæ).

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[a] Bull. 12, Div. Ent., 1886, p. 30.

These and the curiously shaped tree-hoppers (Membracidæ), all of which are more or less injurious, are occasionally taken by the redbird. More often this grosbeak secures the tiny bark-lice or scale insects (Coccidæ). These minute but nevertheless destructive pests, which have not long been known to be preyed upon to any extent by birds, were devoured by 21 cardinals. The cherry scale (*Eulecanium cerasifex*), which is sometimes injurious, was identified from one stomach, while another contained scales which are probably the locust bark-scale (*E. robiniarum*). Other scale insects of the same genus were fed upon by 15 cardinals and those of a related genus (*Toumeyella*) of the southeastern United States by 2.

Other Hemiptera were eaten by 59 grosbeaks, 31 selecting the vile-smelling stinkbugs (Pentatomidæ), including the green tree-bug (*Nezara hilaris*) and 1 specimen of *Euschistus*. The secretions of the latter insect have proved fatal to such hardy creatures even as weevils, but apparently they do not daunt the cardinal. One assassin bug and 1 species of the chinch-bug family also were devoured. Practically all of the Hemiptera eaten are injurious, and some, such as the scale insects, extremely so. Consequently, the cardinal's habit of preying upon them is highly beneficial.

Passing to beetles, we find weevils are eaten to a greater extent than any others. These compactly formed snout-bearers belong to 10 families, members of 3 of which are preyed upon by the cardinal. Most of the weevils attack nuts, fruits, and seeds, including those of cultivated plants. Hence, they are generally harmful and many kinds are exceptionally destructive. Weevils often are obscurely colored and have the habit of feigning death, but notwithstanding these protective devices they are captured in large numbers by all insectivorous birds. One hundred and fifty-seven cardinals ate weevils in quantity sufficient to make 3.26 percent of the food of all examined. Scarred snout-beetles and curculios are equally relished. Sixteen redbirds fed upon a species (*Compsus auricephalus*) of the former group, which, in the adult state, occurs upon the leaves of cotton. The tiniest fragment of this insect suffices for identification, because of the beautiful covering of silvery green and golden scales. Thirteen other grosbeaks ate scarred snout-beetles which can not be identified. Of curculios, the acorn weevil (*Balaninus nasicus*), with a snout almost as long as the body, and several species of 5 weed-mining genera were captured. Six redbirds ate the injurious clover weevils (*Sitones*). The cotton boll weevil (fig. 19) also is occasionally eaten by the cardinal, 2 of the present collection having secured specimens of this highly destructive insect. Twelve redbirds captured curculios which were not further determined. Bill-bugs (fig. 12), which as larvæ live in the roots of grasses or sedges and as adults often injure corn by drilling holes in the stems of young plants, were devoured by 13 cardinals. Two species (*Sphenophorus cariosus* and *S. compressirostris*) were identified.

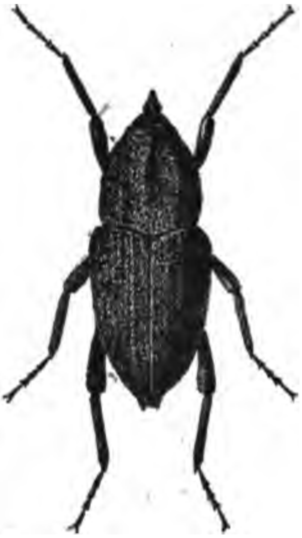

FIG. 12.—A bill bug (*Sphenophorus*). (From Forbes, Illinois Experiment Station.)

Lamellicorn or scarabæid beetles are next in importance to weevils in the beetle diet of the cardinal. They were eaten by 77 birds and compose 2.56 percent of the annual food. Many of them feed on excrementitious matter and are of neutral economic significance; but few of these are consumed by the bird. Those secured include the common road-frequenting dung beetles, which were captured by 6 cardinals, and the large resplendant scavenger *Phanæus carnifex.*

Other species in this family, however, are not so harmless as the above. The spotted vine-chafer (*Pelidnota punctata*), which is an important grape pest in the eastern United States, the two-spotted *Anomala*, which also devours the foliage of the grape, and the cetonias (*Euphoria inda*, fig. 15; *E. fulgida*, et al.), which feed upon all sorts of flowers and sometimes on young Indian corn, are all accepted as food by the cardinal. The southern june beetle or figeater (*Allorhina nitida*, fig. 13), which causes considerable damage in Florida and neighboring States, was found in a few stomachs; but since the cardinal evinces a strong preference for large insects and abounds in this beetle's favorite home, many of them, no doubt, are devoured. Of greatest interest in this family are the rose-chafers (*Macrodactylus subspinosis*, fig. 14.) These beetles are so abundant at times, says Prof. J. B. Smith, that they " ruin not only vineyards, but orchards and gardens, eating every kind of fruit and flower;

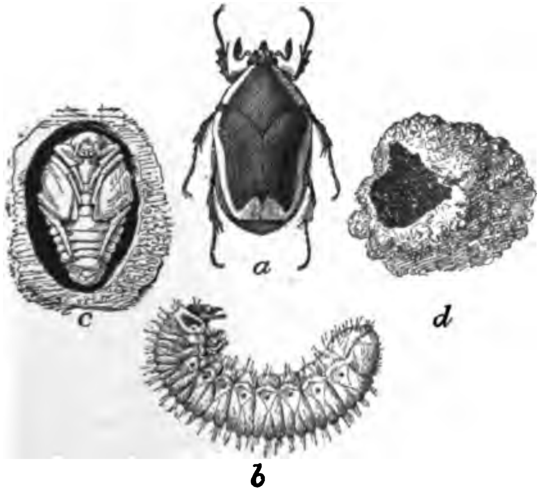

FIG. 13.—Figeater (*Allorhina nitida*). (From Howard, Bureau of Entomology.)

two or three days suffice to ruin a vineyard." These insects have very long and spiny legs, and opinions differ as to whether birds eat them, some affirming that they do, others that they do not. As a matter of fact, they are preyed upon by several wild birds, including the yellow-billed cuckoo, crow blackbird, kingbird, phoebe, green-crested flycatcher, redheaded woodpecker, and cardinal, the last-named being one of the most important of their enemies. Four of the birds examined during the present investigation had eaten rose-beetles, each of them taking several, and on July 5, 1906, the writer watched a brood of young which were being fed rose-chafers, remains of 17 being recovered from ejecta. These facts indicate that the cardinal is so fond of the rose-beetle as to capture it whenever possible. This habit of the bird, together with its inroads upon the vine-chafers of the family, are of considerable economic importance.

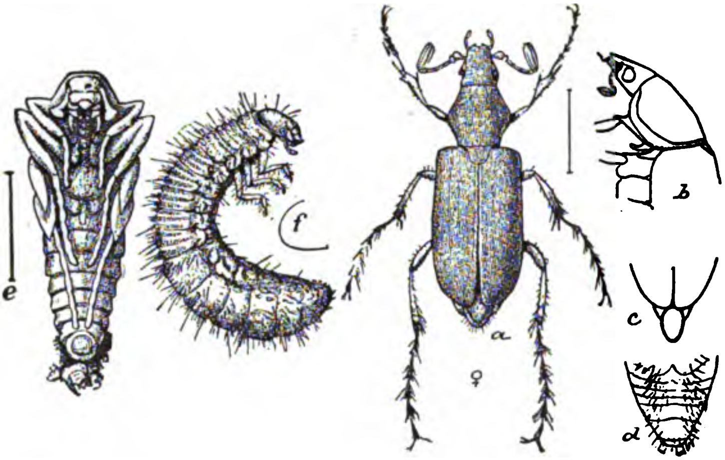

FIG. 14.—Rose beetle (*Macrodactylus subspinosus*). (From Riley, Bureau of Entomology.)

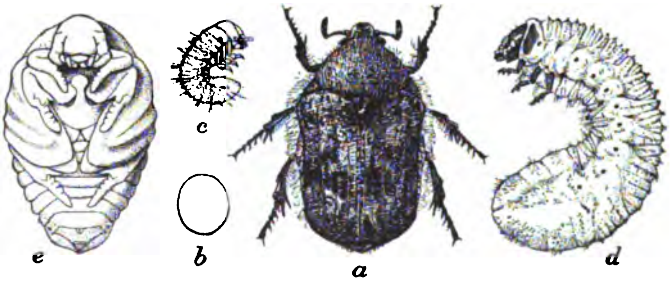

FIG. 15.—Flower eating scarabæid (*Euphoria inda*). (From Chittenden, Bureau of Entomology.)

Next in importance among beetles in the diet of the cardinal grosbeak are the bronzy wood-borers (Buprestidæ), which compose

1.17 percent of the subsistence, being eaten by 31 birds. In the larval state these beetles excavate tunnels in trees and do immense damage. Two species were identified in stomachs of the redbird, namely, the locust borer (*Agrilus egenus*) and another (*Dicerca obscura*) which bores into various deciduous trees. The beetles of this family seem to be a regular item of diet of all kinds of grosbeaks, and we may be sure that their destruction is highly beneficial.

The rather similar appearing click-beetles, adults of the disastrous wireworms, were secured by 23 redbirds. Twelve birds ate long-horned borers (Cerambycidæ), 2 species being identified, neither of which is an important pest. However, the entire family is injurious, and the cardinal should be commended for diminishing the numbers of any of the species.

The closely related family of leaf-beetles (Chrysomelidæ) does not furnish a large percentage of the redbird's fare, although several of its species are captured. The notorious spotted cucumber-beetle (*Diabrotica 12-punctata*, fig. 26), the strawberry root-borer (*Colaspis brunnea*), plum leaf-beetle (*Nodonota tristis*), sweet potato leaf-beetle (*Coptocycla*), willow and poplar species (*Chrysomela bigsbyana* and *Melasoma scripta*), besides some others that feed on weeds and other wild plants, are occasionally eaten. Two additional species, the locust leaf-miner and the three-lined potato beetle, deserve more extended notice. Concerning the locust leaf-mining beetle (*Odontota dorsalis*, fig. 16), Dr. S. D. Judd says, in "Birds of a Maryland Farm:"[a]

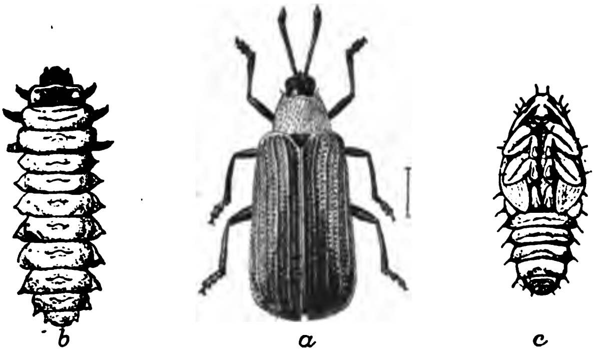

FIG. 16.—Locust leaf-miner (*Odontota dorsalis*). (From Chittenden, Bureau of Entomology.)

> In the summer of 1895 a destructive outbreak * * * turned all the locusts of the farm as brown as if they had been scorched by fire, ruining the verdure of the river bluff. * * * From 1896 to 1902, inclusive, the beetles did not again ruin the foliage. * * * In 1896 the trees further up the river, however, were turned brown, showing that the escape of those at Marshall Hall was not due to climatic conditions unfavorable to the insects; therefore it is possible that the birds were at least to some extent responsible for it.

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[a] Bull. 17, Biological Survey, 1902, pp. 29–30.

The cardinal is one of the birds which assisted in checking this infestation. Two individuals taken at the time had eaten leaf-miners, one having secured no fewer than 10.

Before the advent of the Colorado beetle, a smaller leaf-beetle (*Lema trilineata*), which naturally feeds on ground cherries (*Physalis*), turned its attention to potatoes and made itself widely known. Even at present it is by no means harmless in the Southern States. It is encouraging, therefore, to know that the cardinal seems to relish the species, one bird collected in Florida having eaten 14 of them. The cardinal has been reported to feed upon the genuine potato beetle also, by E. B. Williamson[a] and F. H. Chittenden.[b] Thus while not preying extensively upon the Chrysomelidæ, the redbird at times renders valuable service by eating some of the pests so numerous in the family.

The cardinal occasionally captures a few other kinds of beetles, such as the darkling beetles (Tenebrionidæ) noted for their nauseous secretions, and the blister beetles (Meloidæ), the fluids of whose bodies are highly vesicatory.

But few additional insects are consumed. One cardinal had eaten a two-winged fly, a member of an order the individuals of which are perhaps more abundant than those of any other, yet which is surprisingly exempt from the attacks of birds. Three redbirds devoured fragile mayflies of the kinds that often swarm about the lights of cities. They sometimes eat the larger kinds also, as was observed by Dr. A. K. Fisher, July 4, 1906, when a male cardinal was seen carrying in its beak one of the large dark mayflies (*Hexagenia bilineata*).

Belonging, together with the insects, to the subkingdom of the jointed animals (Arthropoda) are the spiders and centipedes, which in a small way contribute to the fare of the cardinal. One bird had eaten a centipede, while 22 obtained spiders or their egg sacs.

Snails and other mollusks were eaten by a great many of the birds examined, namely 112. Whether they were taken for grinding material or for food is a question, but the latter seems more likely in view of the large number devoured. One grosbeak had eaten several small bivalve shells which must have been obtained from water, and another secured a large slug.

The following note by D. E. Lantz shows that occasionally vertebrates serve as food.[c]

> December 27 [1884], while hunting, I saw a male cardinal grosbeak eating a field-mouse. Several others attempted to take it from him, but were unsuccessful. At my approach they left it lying on the snow. It was about half consumed.

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[a] Proc. Columbus Hort. Soc., XIII, 1898, p. 42.

[b] Circular 87, Bureau of Entomology, 1907, p. 12.

[c] O and O., X, 1885, p. 29.

MINERAL MATTER.

Mineral matter taken for grinding purposes, among which were many bits of cinder in addition to the usual quartz fragments and sand, averaged 5.7 percent of the gross contents of the stomachs examined.

NESTLINGS.

The nestlings of the cardinal, in common with those of most birds, are highly insectivorous. During the preparation of this report 4 have been examined, with the result that 94.75 percent of their food was found to be animal matter and 5.25 vegetable. Two of the number were young, just out of the nest, and they had consumed the vegetable substances; 2 were nestlings, and their diet was entirely animal. The stomach of one of the latter contained the thorax of a large cicada, and that of the other the remaining portions of that luckless insect. Both had been fed caterpillars—purslane (fig. 38) and laurel sphinxes—and each contained grasshoppers and spiders. A few larvæ and eggs of other insects also were in their stomachs. One of the young, just out of the nest, had been given a cicada, and, in addition, some 9 grasshoppers, a snail, and a few seeds, while the other had eaten lamellicorn beetles, weevils, and blackberry seeds. The proportions of the principal food items of the four nestlings are as follows: Cicadas, 17.25 percent; grasshoppers, 20; caterpillars, 21.25; and beetles, 23.25. Two other fledgelings in the collection had only a few bits of snail in their stomachs.

Observations upon nestling birds in the field being recognized as valuable in supplementing data obtained from the examination of stomachs, an effort was made throughout the season of 1906 to locate and thoroughly study a grosbeak family. Owing to various vicissitudes, satisfactory observations were made upon only one nest. Fifty-six trips by the parents were made to this nest in six and one-half hours, an average of 8.6 an hour. The young were fed 178 times, an average of 89 each. The longest interval between visits was thirty-five minutes, the shortest two.

The character of the food could not be determined by observation, but it was learned in another way. None of the excrement was removed from the box, whereas the nest in which the youngsters had been reared was kept perfectly clean. The fecal matter was dried and examined, and while by no means all of its constituents could be identified, enough was learned to indicate that the study of excreta is a very satisfactory method of determining the food of nestling birds. The nest of any fairly bold bird may be kept under surveillance and the waste matter collected before the parents remove it. The extent of the information as to the food eaten by the young to be obtained in this way is astonishing.

For instance, a single casting of a young cardinal, covered with its thick, chalky, and gelatinous layers, was preserved, and from it were taken the following: One insect egg, the leg and scutellum of a scarabæid beetle, head and other remains of a leaf-hopper, bits of a snail, and 11 seeds and the core of a mulberry. From the remainder of the total quantity the following were identified: Seventeen rose-beetles (*Macrodactylus subspinosus*, fig. 14), 2 other scarabæids, 1 click beetle (*Limonius* sp.), 1 caterpillar hunter (*Calosoma scrutator*, fig. 7), 1 leaf-hopper (Jassidæ), 3 grasshoppers, 1 spider, 1 dragon fly, many bits of snail, 17 blackberry seeds (*Rubus* sp.), and 221 seeds of mulberry (*Morus rubra*). The only beneficial species in the above list is the caterpillar hunter, while among the injurious forms, four in number, the rose-beetle is very important. This insect's habits, as well as its occasional overwhelming abundance, have been described on a preceding page.

The infestation of the insect about the District of Columbia in 1906 was especially severe. Not only roses were attacked by the insects, but elder blossoms were covered, and around the basswoods their humming was as loud as of a swarm of bees. Frequent attempts were made to discover whether the cardinal feeds upon them, but no opportunity was afforded until the above-mentioned nestlings were discovered at the extreme end of the rose-beetle season. The fact that so many were taken at that time is good evidence that special search was made for them.

Among the food given to the inmates of a nest under observation in 1907, the following were identified by sight: A chrysalis, a caterpillar or sawfly larvæ, a horsefly, and a grasshopper. From a small quantity of excrement were recovered bits of snail, grass seed, a small caterpillar, ground and click beetles, and 3 rose-beetles. The capture of the latter is again significant, as they were very scarce up to that time. This fondness for rose-beetles distinguishes the bird as an important guardian of the plants the insects attacks.

SUMMARY.

Examination of nearly 500 stomachs of cardinals shows that the bird's diet is about three-tenths animal and seven-tenths vegetable.

The cardinal has been accused of pilfering certain grains, notably corn, to an injurious extent, which charge the evidence from stomach examination neither proves nor disproves. But in view of the fact that only 8.73 percent of the total food is grain, and that more than half of that amount is waste, the loss is greatly overbalanced by the destruction of weed seeds alone, which compose more than half of the vegetable food. Moreover, some of the weeds consumed are especially destructive to grain crops.

In securing its insect food the cardinal injures us in 1 case and benefits us in 15. In other words, considering the animal food alone, only 1 cardinal does harm to 15 which do good. The presence of this single harmful bird among so many beneficial ones no more justifies us in classing the species as injurious than would a like proportion of disabled men justify the condemnation of a whole regiment.

On the contrary, since the cardinal, by its general food habits, does at least 15 times more good than harm, it must be classed among the very useful species. The following list of important pests the bird has been shown to prey upon is in itself sufficient proof of the cardinal's value. The list includes the Rocky Mountain locust, 17-year cicada, potato beetle, cotton worm, bollworm, cotton cutworm, cotton-boll weevil, codling moth, rose-beetle, cucumber-beetle, fig-eater, zebra caterpillar, plum scale, and other scale insects. A host of minor insect pests are attacked and the seeds of many noxious weeds are destroyed. The cardinal much more than pays its way, and deserves and should receive strictest protection. The bird is easily attracted by food in winter and by the provision of suitable nesting sites in summer. Being thus responsive to human care, and being so valuable economically, the cardinal's presence on the farm, and even in the city garden, should be encouraged in every possible way. With proper protection and encouragement it will become more and more numerous and render husbandry a correspondingly increased amount of useful service.

LIST OF SEEDS, FRUITS, AND INVERTEBRATES EATEN BY THE CARDINAL.

GRAIN.

Corn (*Zea mays*).
Rice (*Oryza sativa*).
Kafir corn (*Sorghum vulgare durra*).
Oats (*Avena sativa.*)
Wheat (*Triticum vulgare*).

WILD FRUITS.

Red cedar (*Juniperus virginiana*).
Solomon's seal (*Pologonatum biflorum*).
Bristly greenbrier (*Smilax bona-nox*).
Hickory (*Hicoria* sp.).
Oak (*Quercus* sp.).
Southern hackberry (*Celtis mississippiensis*).
Hackberry (*Celtis occidentalis*).
Mulberry (*Morus* sp.).
Pokeberry (*Phytolacca decandra*).
Tulip tree (*Liriodendron tulipifera*).
Spicebush (*Lindera benzoin*).
Blackberry (*Rubus* sp.).
Rose (*Rosa* sp.).
Juneberry (*Amelanchier canadensis*).
Red haw (*Cratægus* sp.).
Cherry (*Prunus* sp.).
Skunk bush (*Rhus trilobata*).
Poison ivy (*Rhus radicans*).
Holly (*Ilex opaca*).
Inkberry (*Ilex glabra*).
Maple (*Acer* sp.).
Summer grape (*Vitis aestivalis*).
Frost grape (*Vitis cordifolia*).
Bullace grape (*Vitis rotundifolia*).
Maypop (*Passiflora incarnata*).
Prickly pear (*Opuntia opuntia*).
Rough-leaved cornel (*Cornus asperifolia*).
Flowering dogwood (*Cornus florida*).
Blueberry (*Vaccinium virgatum*).
Knockaway tree (*Ehretia elliptica*).
Nightshade (*Solanum* sp.).
Elder (*Sambucus* sp.).
Arrowwood (*Viburnum* sp.).

WEEDS.

- Large crab grass (*Syntherisma sanguinalis*).
- Barnyard grass (*Echinochloa crus-galli*).
- Yellow foxtail (*Chætochloa glauca*).
- Bur grass (*Cenchrus tribuloides*).
- Wire grass (*Eleusine indica*).
- Sedge (*Carex* sp.).
- Spiderwort (*Tradescantia* sp.).
- Rush (*Juncus* sp.).
- Star grass (*Hypoxis hirsuta*).
- Star grass (*Hypoxis juncea*).
- Dock (*Rumex* sp.).
- Knotgrass (*Polygonum aviculare*).
- Pale persicaria (*Polygonum lapathifolium*).
- Pennsylvania persicaria (*Polygonum pennsylvanicum*).
- Smartweed (*Polygonum punctatum*).
- Virginia knotweed (*Polygonum virginianum*).
- Hastate tearthumb (*Polygonum arifolium*).
- Goosefoot (*Chenopodium* sp.).
- Pigweed (*Amaranthus* sp.).
- Chickweed (*Alsine media*).
- Vetch (*Vicia* sp.).
- Cranesbill (*Geranium* sp.).
- Sorrel (*Oxalis* sp.).
- Croton (*Croton* sp.).
- Spurge (*Euphorbia* sp.).
- Spiny sida (*Sida spinosa*).
- Violet (*Viola* sp.).
- Dodder (*Cuscuta* sp.).
- Stickweed (*Lappula* sp.).
- Gromwell (*Lithospermum arvense*).
- White vervain (*Verbena urticaefolia*).
- Blue vervain (*Verbena hastata*).
- Rib grass (*Plantago lanceolata*).
- Plantain (*Plantago* sp.).
- Buttonweed (*Diodia teres*).
- Prickly sow-thistle (*Sonchus asper*).
- Ragweed (*Ambrosia artemisiaefolia*).
- Sunflower (*Helianthus* sp.).
- Sticktight (*Bidens* sp.).

COLEOPTERA.

- Ground beetles (Carabidæ):
  - *Calosoma scrutator.*
  - *Pasimachus* sp.
  - *Scarites subterraneus.*
  - *Dicaelus* sp.
  - *Callida* sp.
  - *Harpalus caliginosus.*
  - *Anisodactylus rusticus.*
  - *Anisodactylus agricola.*
- Click-beetles (Elateridæ):
  - *Melanotus sp.*
- Bronzy wood-borers (Buprestidæ):
  - *Dicerca obscura.*
  - *Agrilus egenus.*
- Fireflies (Lampyridæ):
  - *Chauliognathus marginatus.*
  - *Telephorus pusillus.*
- Lamellicorn beetles (Scarabæidæ):
  - *Phanaeus carnifex.*
  - *Aphodius lividus.*
  - *Aphodius inquinatus.*
  - *Macrodactylus subspinosus.*
  - *Anomala binotata luteipennis.*
  - *Pelidnota punctata.*
  - *Allorhina nitida.*
  - *Euphoria fulgida.*
  - *Euphoria inda.*
- Long-horned beetles (Cerambycidæ):
  - *Liopus adspersus.*
  - *Hippopsis lemniscata.*
- Leaf-beetles (Chrysomelidæ):
  - *Donacia* sp.
  - *Lema trilineata.*
  - *Cryptocephalus calidus.*
  - *Colaspis brunnea.*
  - *Nodonota tristis.*
  - *Chrysomela* sp.
  - *Calligrapha bigsbyana.*
  - *Zygogramma heterotheca.*
  - *Melasoma scripta.*
  - *Diabrotica 12-punctata.*
  - *Odontota dorsalis.*
  - *Coptocycla* sp.
- Darkling beetles (Tenebrionidæ):
  - *Blapstinus pratensis.*
- Blister beetles (Meloidæ).
- Scarred snout-beetles (Otiorhynchidæ):
  - *Graphorhinus vadosus.*
  - *Compsus auricephalus.*
- True snout-beetles (Curculionidæ):
  - *Sitones* sp.
  - *Pachytychius amœnus.*
  - *Anthonomus grandis.*

COLEOPTERA—continued.

- True snout-beetles—Continued.
  - *Conotrachelus* sp.
  - *Tyloderma baridium.*
  - *Baris interstitialis.*
  - *Balaninus nasicus.*
- Billbugs (Calandridæ):
  - *Rhodobaenus 13-punctatus.*
- Billbugs—Continued.
  - *Sphenophorus cariosus.*
  - *Sphenophorus compressirostris.*
- Barkbeetles (Scolytidæ):
  - *Tomcius impressus.*

HEMIPTERA.

- Cicadas, (Cicadidæ):
  - *Cicada tibicen.*
- Tree-hoppers (Membracidæ).
- Leaf-hoppers (Tettigonidæ).
- Jumping plant-lice (Psyllidæ).
- Scale insects (Coccidæ):
  - *Eulecanium cerasifex.*
  - *Eulecanium robiniarum* (?).
- Scale insects—Continued.
  - *Toumeyella* sp.
- Stink-bugs (Pentatomidæ):
  - *Euschistus* sp.
  - *Nezara hilaris.*
- Lygæidæ.
- Assassin bugs (Reduviidæ).

ORTHOPTERA.

- Short-horned grasshoppers (Acrididæ):
  - *Melanoplus atlanis.*
  - *Tettix* sp.
- Long-horned grasshoppers (Locustidæ).
- Crickets (Gryllidæ).

LEPIDOPTERA.

- Hawk-moths (Sphingidæ):
  - *Deilephila lineata.*
  - *Sphinx kalmiæ.*
- Owlet-moths (Noctuidæ):
  - *Mamestra picta.*
  - *Prodenia ornithogalli.*
  - *Alabama argillacea.*
- Owlet moths—Continued.
  - *Heliothis obsoleta.*
- Spanworms (Geometridæ):
  - *Nadata gibbosa.*
- Leaf-rollers (Tortricidæ):
  - *Carpocapsa pomonella.*

HYMENOPTERA.

- Rough-headed ants (Myrmicidæ):
  - *Pogonomyrmex* sp.
- Smooth-headed ants (Formicidæ):
  - *Lasius* sp.
- Sawflies (Tenthredinidæ).

OTHER INSECTS.

- Dragon fly (Odonata).
- *Mantispa brunnea* (Neuroptera).
- Two-winged fly (Diptera).
- Mayfly (Ephemerida).

OTHER INVERTEBRATES.

- Spiders (Araneida).
- Centipedes (Chilopoda).
- Snails and slugs (Gastropoda).
- Bivalves (Pelecypoda).

GRAY GROSBEAK.

(*Pyrrhuloxia sinuata.* Plate I, Frontispiece.)

APPEARANCE, DISTRIBUTION, AND HABITS.

This grosbeak, which so far has received no distinctive popular name, may be known as the gray grosbeak or parrot-bill. It is almost the same size as the cardinal, closely resembles that species in song and general demeanor, and has similar nesting habits. Moreover, it frequents the same kind of country and is resident wherever found. In appearance, however, it is quite dissimilar.

In strong contrast to the glowing hue of the cardinal, the general color of both sexes of the parrot-bill is light gray. The wings, tail, and long crest are suffused with dark red and the wings are lined with rose. This color also surrounds the beak of the male and extends over throat and breast in an irregular patch. The beak is yellowish and is very curiously modified, being short, thick, strongly curved, and apparently of great power.

The gray grosbeak occurs over about the lower third of Arizona and New Mexico and the lower half of Texas, not reaching, however, the extreme eastern part of the latter State. There are two subspecies, the Arizona parrot-bill (*P. sinuata*) and the Texas parrot-bill (*P. s. texana*). Their range extends south to central Mexico.

ECONOMIC RELATIONS.

Seventy-four stomachs of gray grosbeaks have been examined. All are from Texas, 59 being collected in August and 15 in September. They do not, therefore, give an adequate idea of the food habits of the species, except for that locality and season. Vegetable matter averages 71.19 percent of the contents, and animal matter 28.81 percent. Contrasting the latter amount with 36.54 percent of animal food obtained during a corresponding period by the cardinal, which is highly vegetarian, it appears exceedingly low. It is accounted for, however, by the extraordinary preference of the parrot-bill for a single item of its vegetable diet, namely, the seeds of grasses.

VEGETABLE FOOD.

Another remarkable feature of the vegetable diet is the scarcity of fruit. Only a few pokeberries were eaten, not enough in fact to be allotted a percentage valuation. Cardinals, however, collected in the same locality at the same time consumed almost 12 percent of fruit in August and nearly 30 percent in September. It appears, therefore, that the gray grosbeak is distinguished from its nearest relative by a remarkable indifference for fruit.

WEEDS.

Grass seeds constitute an average of 53.09 percent of the total food of the birds examined, or more than five-sevenths of the vegetable food alone. Most important among them are foxtail (*Chætocholoa*, fig. 17) and bur grass (*Cenchrus*, Plate II, fig. 10), which together amount to 43.59 percent of all the bird's food. Since these grasses are among the most pernicious weeds, the parrot-bill is more than welcome to all of their seeds it desires.

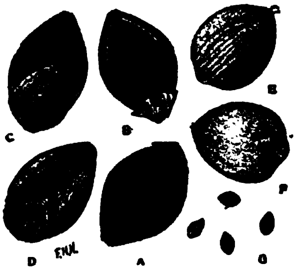

FIG. 17.—Seeds of yellow foxtail (*Chætochloa glauca*). (From Hillman, Nevada Experiment Station.)

The seeds of other grasses also are important, furnishing 9.51 percent of the bird's subsistence. Among them are seeds of witch and crab grasses, most species of which are weeds. Yard or wire grass (*Eleusine indica*) also is eaten. Seeds of a spurge (*Croton* sp.) contribute 9.81 percent to this grosbeak's fare, and other weeds, including bindweed (fig. 21), lambs' quarters, tumbleweed (fig. 18), sunflower, carpet weed, nightshade, vervain (fig. 3), mallow, etc., compose 6.13 percent.

Thus the gray grosbeak is a great consumer of weed seeds, and it is remarkable that seeds form practically seven-tenths of the food in August and September, when insects are superabundant. The bird's habit of feeding upon weeds is undoubtedly beneficial, especially because it eats so many seeds of foxtail and bur grass, pests with which every farmer in the South has to contend.

GRAIN.

The only grain found in stomachs of this species is sorghum. Six birds had eaten it in quantity sufficient to make an average of 2.03 percent of the total food. Ignoring even the fact that sorghum is usually grown for fodder, not for grain, the amount consumed is so small that there need be no fear of damage by this shy and uncommon bird.

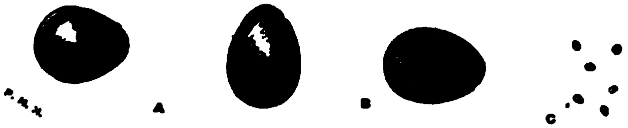

FIG. 18.—Seeds of rough tumbleweed (*Amaranthus retroflexus*). (From Hillman, Nevada Experiment Station.)

ANIMAL FOOD.

While the parrot-bill consumes a smaller proportion of animal matter than other grosbeaks, it selects about the same things, the principal items being grasshoppers, caterpillars, and beetles.

Neither parasitic Hymenoptera nor predaceous beetles were found in the stomachs examined, a showing much to the bird's credit. Only one useful insect had been eaten, it belonging to the queer neuropteroid genus *Mantispa*, the members of which are rare. They are predaceous when adult and when young are parasitic in the egg-sacs of spiders.

The remainder of the animal food is composed of injurious species, among which are important pests. Beetles constitute 4.66 percent of the food, weevils alone being 3.42. Of greatest interest among the latter is the cotton-boll weevil (*Anthonomus grandis*, fig. 19), the most serious agricultural pest of recent years. While the gray grosbeak does not feed upon it regularly, nevertheless the habit of picking it up when occasion offers is highly commendable. Among other weevils eaten are additional species of curculionids and scarred snout-beetles, including the same silvery-green and golden species (*Compsus auricephalus*) eaten by the cardinal.

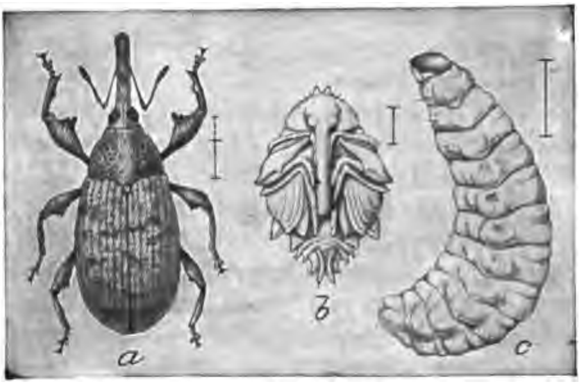

FIG. 19.—Cotton-boll weevil (*Anthonomus grandis*). (From Howard, Bureau of Entomology.)

Leaf beetles (Chrysomelidæ) probably are next in importance. The parrot-bill is sharp-eyed enough to find a species (*Chlamys plicata*) of this family that is noted for the perfection of its protective devices. This little beetle is curiously sculptured and has furrows in which all the appendages fold, and, being bronzy in color, its resemblance to the droppings of caterpillars is almost perfect. The *Chlamys* sometimes feeds upon raspberry leaves, but has never been found very injurious. Nevertheless, it is entirely vegetarian, like all the other beetles of the family, species of which, even if not at present positively injurious, are liable to become so at any time. The parrot-bill should receive nothing but praise for its destruction of leaf-beetles.

Bronzy wood-borers (Buprestidæ) and long-horned beetles (Cerambycidæ), both of which are destructive to forest and orchard trees, also were found in stomachs of this species.

Beetles, as a whole, are exceeded in amount by caterpillars, the latter constituting 10.32 percent of the diet. One of the species identified, namely, the cotton worm (*Alabama argillacea*, fig. 20), has long been known as a great pest throughout the Southern States, and in certain years has caused a decrease in the crop of a quarter of a million bales, valued at $25,000,000. Many birds devour great numbers of cotton worms, and this fact alone justifies the oft-repeated statement that "too much can hardly be said in favor of insectivorous birds in cotton fields." The gray grosbeak assumes a proper share in this valuable work, 14 of the 74 individuals examined having consumed cotton worms, which formed an average of 39.1 percent of their food. As many as 18 caterpillars were found in a single stomach. Another caterpillar enemy of the same crop, the cotton cutworm (*Prodenia ornithogalli*, fig. 9), also is freely devoured.

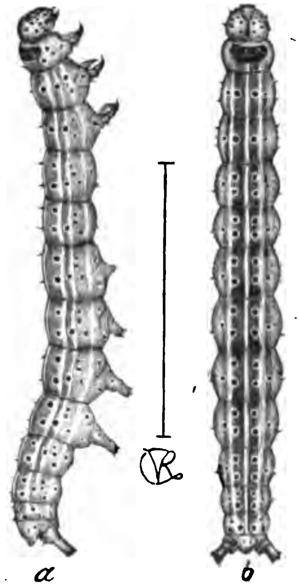

Fig. 20.—Cotton worm (*Alabama argillacea*). (From Riley, Bureau of Entomology.)

As beetles were less esteemed than caterpillars by the gray grosbeak, so also are the latter less liked than the Orthoptera. This group contributes 11.52 percent of the total food. Both long and short-horned locusts and their eggs are devoured, 7 or 8 grasshoppers sometimes being secured by a single bird. The only species (*Syrbula admirabilis*) identified sometimes feeds on timothy.

True bugs, comprising stink-bugs (Pentatomidæ) and their eggs, cicadas, leafhoppers (Jassidæ), and lantern flies (Fulgoridæ) compose about 1.5 percent of the food. All of these insects are injurious and the bird does a service by feeding upon them.

One parrot-bill was bold enough to swallow a large hornet (*Vespa* sp.). A few ants also were eaten, and these, together with spiders and snails, complete the list of animals devoured. Although this grosbeak is not conspicuously insectivorous, almost all the insects it eats are injurious.

MINERAL MATTER.

While mineral matter was absent from the majority of the stomachs examined, enough was contained in the remainder to make an average of 3.62 percent for the whole number.

SUMMARY.

The present incomplete data indicate that for a grosbeak the parrot bill is decidedly vegetarian, preferring vegetable food even in months when insects abound. More than 69 percent of its food during August and September consists of weed seeds, the small amount of grain taken bringing the total amount of vegetable food up to 71.19 percent. More than half of the total subsistence consists of grass seeds alone.

The 28.81 percent of animal food is made up almost exclusively of harmful species, among which are the most important pests of the cotton plant, namely, the cotton worm and the cotton boll weevil.

Although the data on hand are insufficient to determine the exact economic status of the bird, it may be stated with confidence that the gray grosbeak is almost entirely beneficial.

LIST OF SEEDS AND INVERTEBRATES EATEN BY THE GRAY GROSBEAK.

GRAIN.

Kafir corn (*Sorghum vulgare durra*).

WEEDS.

Joint grass (*Paspalum* sp.).
Crab grass (*Syntherisma* sp.).
Yellow foxtail (*Chætochloa glauca*).
Bur grass (*Cenchrus tribuloides*).
Wire grass (*Eleusine indica*).
Bindweed (*Polygonum* sp.).
Goosefoot (*Chenopodium* sp.).
Rough pigweed (*Amaranthus retroflexus*).
Pokeweed (*Phytolacca decandra*).
Carpetweed (*Mollugo verticillata*).
Sorrel (*Oxalis* sp.).
Spurge (*Euphorbia* sp.).
Croton (*Croton* sp.).
Mallow (*Malva* sp.).
Sida sp.
Vervain (*Verbena* sp.).
Nightshade (*Solanum* sp.).
Sunflower (*Helianthus* sp.).

COLEOPTERA.

Bronzy wood-borers (Buprestidæ).
Long-horned beetles (Cerambycidæ):
  Liopus crassulus.
  Hippopsis lemniscata.
Leaf-beetles (Chrysomelidæ):
  Chlamys plicata.
Scarred snout-beetles (Otiorhynchidæ):
  Compsus auricephalus.
True snout-beetles (Curculionidæ):
  Anthonomus grandis.
  Acalles sp.

HEMIPTERA.

Cicadas (Cicadidæ):
  Cicada sp.
Leaf-hoppers (Jassidæ).
Lantern flies (Fulgoridæ).

ORTHOPTERA.

Short-horned grasshoppers (Acridiidæ):
  Syrbula admirabilis.
Long-horned grasshoppers (Locustidæ).

LEPIDOPTERA.

Owlet-moths (Noctuidæ):
  Prodenia ornithogalli.
  Alabama argillacea.

HYMENOPTERA.

Hornets (Vespidæ):
  Vespa sp.

Smooth-headed ants (Formicidæ).

NEUROPTERA.

Mantispidæ: *Mantispa* sp.

OTHER INVERTEBRATES.

Spiders (Araneida).

Snails (Gastropoda).

ROSE-BREASTED GROSBEAK.

(*Zamelodia ludoviciana,* Plate III.)

APPEARANCE, DISTRIBUTION, AND HABITS.

The rose-breasted grosbeak, one of the loveliest and most valuable of our North American birds, is easily recognized by its characteristic coloring and big bill. The male is gayly clad in rose, white, and black, the brightest tint partly covering the breast and lining the wings. The female, while soberly clothed in buffy, grayish, and brown, can not be mistaken, once the appearance of the species is familiar, the plump form and thick bill sufficiently distinguishing her.

The song of the male rosebreast is as charming as his appearance is striking, its notes being among the sweetest and most inspiring of the avian chorus. The bird seems never to tire of his music and may be heard during the hottest days and even at night. However, he is also a paragon of domesticity, taking turn with the female in incubating the eggs and later doing yeoman service in feeding the young.

The bulky and loosely-fashioned nest is built in June, and 3 or 4 eggs are laid. The nests are very often placed in orchard trees; indeed, where conditions permit, they are almost invariably in the vicinity of cultivated lands.

The birds are fairly common, especially in the northern part of their range, but they are not evenly distributed. For instance, in one locality, for no obvious reasons, grosbeaks are absent, while in another near by several pairs may live. In Wisconsin 7 nests have been found in a space of not over 5 acres, and on the brushy banks of a little stream in New Jersey 11 pairs nested within a quarter of a mile. If these figures held for any considerable area, they would indicate that the bird was very abundant, and indeed it would appear that in most accounts the number of rose-breasted grosbeaks has been underestimated, unless we are to assume that of late years the bird has increased in numbers greatly. In parts of New England during the last twenty years the bird is known to have increased, and where once rare it is now common. In western Pennsylvania rosebreasts are said to be as common as song sparrows, and E. A. Preble, of the Biological Survey, found them in migration one of the commonest birds along the Athabaska River, near the northern limit of their distribution.

The rosebreast ranges farther north than any other of the group of grosbeaks here treated. Breeding from the latitude of St. Louis and northeastern Kansas and in the Alleghenies from southern Tennessee, it occurs as far north as Newfoundland and Quebec in the east and in the west extends through the Dakotas and lower Saskatchewan to Peace River Landing, Alberta, and the vicinity of Fort Smith, Mackenzie—the latter locality only 6° from the Arctic Circle. In winter the species is found from southern Mexico to below the Equator in Ecuador.

ECONOMIC RELATIONS.

Much interest attaches to the present species because of its well-known fondness for the Colorado potato beetle. More than 35 printed articles of greater or less length have been devoted to the bird because of this habit, and brief reports upon it appear in four previous publications of the Biological Survey.[a]

One hundred and seventy-six stomachs of the rosebreasted grosbeak are available for present examination, and these were obtained in the seven months from April to November (excepting October), from 17 States and the District of Columbia, besides Nova Scotia, Ontario, and Northwest Territory.

A detailed inventory of the contents of these stomachs having been made and the results tabulated, it was found that the bird consumes an average of 52 percent of animal matter and 48 percent of vegetable per month during its stay in the summer home. The maximum amount (74.25 percent) of animal food is taken in June, the nesting month. Remarkable features of the food habits are the apparent disinclination for grasshoppers and the strong preference for wild fruits.

VEGETABLE FOOD.

The vegetable part of the diet is composed of the following elements: Weed seed, 15.74 percent; grain, 5.09 percent; garden peas, 1.37 percent; wild fruit, 19.3 percent, and other vegetable matter, including a small quantity of cultivated fruit, besides buds, flowers of trees, etc., 6.5 percent.

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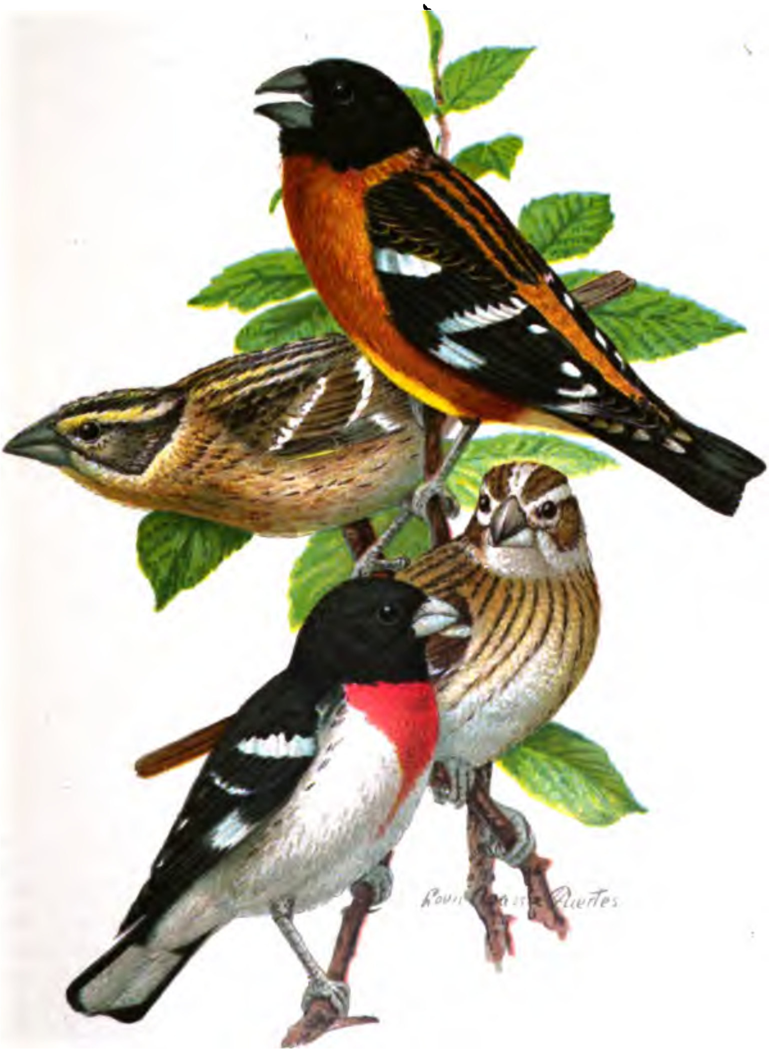
[a] Barrows, W. B., Rep. Commr. Agr. (1888), 1889, pp. 535–536; Merriam, C. Hart, Rep. Commr. Agr., 1889, p. 369; Beal, F. E. L., Farmers' Bull. 54, 1897, pp. 28–30; Beal, F. E L., Farmers' Bull. 54, rev. ed., 1904, pp. 34–35.

PLATE III.



BLACK-HEADED AND ROSE-BREASTED GROSBEAKS.

[Upper figures, black-headed grosbeaks, male and female; lower figures, rose-breasted grosbeaks, female and male.]

The items obtained from cultivated crops, being of chief interest, will be considered first. While it is needless to state that most of the testimony regarding the value of this bird is favorable, yet complaints of injury from it have been made which are verified by stomach examinations. The crop most frequently attacked by rose-breasted grosbeaks is the common garden pea.

PEAS.

Ten accounts from correspondence and published writings go to show that this grosbeak sometimes feeds upon peas. Six of them refer to damage in Iowa, two in Illinois, one in Massachusetts, and one general. Three persons regard the bird as very destructive: three, while stating that injury is committed, are less severe in their strictures; while the remaining four, admitting the consumption of a few peas, consider the bird's services in preying upon injurious insects ample compensation for the loss sustained.

The attacks of this bird upon peas were observed as early as 1839, W. B. O. Peabody[a] writing as follows:

> At the latter part of the summer, our gardens are frequented by the young in great numbers, and bitter complaints are made, with or without reason, of their depredations on the peas.

Among more recent charges of injury, that of H. J. Giddings, of Sabula, Iowa, may be cited, both because the amount of damage is extreme, and further because the observations are supported in part by stomach examination. Mr. Giddings says:

> During the last summer [1892] rosebreasted grosbeaks were unusually numerous here. * * * The last two weeks in June and the first week in July (after the young had left the nest) they became very destructive, eating all kinds of fruit and entirely destroying a small patch of green peas in my garden. (Nov. 18, 1892.)

Six grosbeak stomachs were sent in from this and other gardens where the birds had access to peas, but examination disclosed peas in only two of them, constituting in one case 10 percent of the stomach contents and in the other 80 percent. Peas were found in one other stomach also, of the 176 examined, this having been collected in Minnesota in July. It held 4 peas, which were 80 percent of the contents. Were there no other evidence, the above is sufficient to show that the rosebreast has a taste for green peas which is sometimes gratified at the expense of the gardener.

Some observers believe, however, that the bird makes full reparation for damage done. E. M. Hancock, of Waukon, Iowa, states:

> The rosebreasted grosbeak has more than made amends for its pea stealing by its determined warfare upon the Colorado potato beetle, helping very materially to keep down this pest. (April, 1886.)

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[a] Birds of Massachusetts, 1839, p. 329.

Henry Nehrling[a] writes:

> It is said to eat green peas, and for this reason it is often killed, though the damage done in this way does not compare with the many benefits it bestows.

The question is, Do stomach examinations support this view? Years ago Prof. F. E. L. Beal observed the rosebreast in the act of eating peas and found the pods cut open and the peas gone; the contents of a stomach were examined, and two or three peas, several potato beetles, and a tomato worm were found; whence it is evident that this particular grosbeak, at least, was paying well for its peas.

In this connection the record of 6 birds from Iowa gardens is of interest. Fifteen percent of their food was peas, and to that extent, of course, they were detrimental; but as an offset more than 17 percent consisted of bronzy wood-borers and 12.5 percent of weevils, including the injurious pine bark-weevil and 2 nut weevils. While these insects are very injurious to timber, it may be claimed that they are not of direct consequence to the gardener. But insects especially injurious to garden crops also were consumed, 14.8 percent of the food consisting of white grubs, which are enemies of strawberries, and a flower beetle, which injures young corn and many fruits, besides the notorious Colorado potato beetle. Caterpillars and ants also were preyed upon by these 6 birds, and scale insects (*Eulecanium* sp.), the very worst pest of fruit trees, formed 4.5 percent of their food. The gardener is vitally concerned in reducing the numbers of these insects, and it is evident that the 15 percent of peas consumed is paid for many times over by the destruction of more than three times that amount of garden and forest enemies. Moreover, to determine the true significance of the damage done, not only the birds which had eaten peas, but the species collectively must be considered. The present investigation shows that 3 birds out of 176 had stolen peas, while scores had literally feasted upon the worst enemies of agriculture. Peas constitute 1.36 percent of the total food of the grosbeaks examined, while noxious insects certainly compose thirty times as much. Viewed in the light of these facts, the loss sustained would be nothing compared to the benefits received were it not for the fact that the birds' depredations are often local in character, as in the case cited above, one cultivator, perhaps, furnishing the supply of peas for all the grosbeaks in the neighborhood.

However, even under such circumstances a remedy is available without the necessity of sacrificing the birds. Wire guards or bird netting afford protection, and in the case cited above Professor Beal at once stopped the grosbeaks' visits to his pea patch by means of an old coat on a pole.

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[a] Our Native Birds of Song and Beauty, II, 1896, p. 206.

GRAIN.

Grain composes 5.09 percent of the food of the 176 rose-breasted grosbeaks examined, the cereals selected being corn, wheat, and oats. The bird has been accused of injuring each of these products, and stomach examinations lend support to the complaints.

Corn.—Part of the damage to corn is of an unusual nature. H. S. Giddings, of Sabula, Iowa, writing about the same grosbeaks mentioned above as injurious to peas, says:

> From the time they arrived until their departure they fed continuously on corn from a crib on my place. * * * Sometimes as many as 10 or 12 would be in the crib at once.

The stomachs of 3 grosbeaks shot at this time contained corn, the grain constituting in each case about half the contents. Notwithstanding these facts, it is very doubtful if any considerable damage is ever committed in the manner described, if for no other reason than that the opportunity is seldom presented. Moreover, such depredations are easily prevented by simple and inexpensive means, such as lining the crib with wire netting and closing the doors when not in use. These precautions will not only keep out wild birds, but also rats, mice, and chickens, which animals undoubtedly destroy vastly more stored grain than all native birds together.

A small quantity of the corn eaten by the rose-breasted grosbeak may be pilfered from the growing crop, one bird taken in Pennsylvania in July having eaten enough corn to form 8 percent of its stomach contents, and one from Illinois in September consumed 50 percent. There is no way of determining positively whether this grain was crop corn or waste; but if only 2 grosbeaks out of 176 take corn from the ear, there is no cause for alarm. The corn obtained in May by 2 other rosebreasts from Illinois and Minnesota may have been either seed or waste.

Oats.—Seed oats may sometimes be devoured by grosbeaks. E. A. Mearns says:[a]

> Where fields newly sown with the cereal grains are convenient to its woodland retreats, it. * * * will collect in large flocks, and resort there continually, as long as there is a grain of seed to be had.

As this statement refers to a locality in New York where the rosebreast occurs only from May to September, the crop in question must be oats.

This grain was eaten by 5 of the birds examined, 4 of which may have obtained it from newly sown fields, but even this trifling injury to the crop may be prevented and other advantages secured by drilling. The fifth grosbeak, which was collected in Illinois in July, probably obtained the oats it devoured from standing grain.

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[a] Bull. Essex Inst., 12, 1880, p. 21.

Wheat.—A certain quantity of wheat also may be taken from the heads, but no complaints of such damage have been received, the only observation at hand which bears upon the point being that of Audubon. Referring to a brood of young rose-breasted grosbeaks in the vicinity of Cincinnati, he says:[a] "The parents fed them on the soft grains of wheat which they procured in a neighboring field." Four grosbeaks out of the 176 examined had fed upon wheat. That obtained by 1 collected in Connecticut in May is obviously waste, but 3 birds, which had eaten wheat during July and August in Iowa and Illinois, may have attacked standing grain. These 4 birds obtained about 3 kernels of wheat each, which is an average of less than a fourteenth of a kernel apiece for the 176 grosbeaks examined. Now, if the proportion of grosbeaks eating wheat, 4 to 176, or thereabouts, holds true for this species at large, and the birds do not exceed the moderate average of 3 kernels each, it would require the united efforts of the grain eaters among some 300,000 grosbeaks to consume a quart (21,000 kernels) of average wheat. It is evident, therefore, that the rosebreast's wheat-eating habits can not be termed injurious.

To sum up the rosebreast's relation to grain crops, as shown by the present investigation, 15 birds out of a total of 176 fed upon grain, including oats, wheat, and corn. Wheat and corn eaten by 4 of these very probably was waste, while 3 birds had taken corn from a crib, and 4 had eaten oats which may have come from newly sown fields. In both cases the injury was easily preventable. Six grosbeaks, consuming one or the other of the grains mentioned, may have pilfered standing crops. This latter injury to grain constitutes the only real case against the bird, and involves only 1.17 percent of the total food of the birds examined. If this ratio holds true for the entire species, the damage is of no special consequence. This view is further strengthened by the fact that no complaints have been made of injury to standing grain, the only stage in which it is subject to attack under the best methods of culture.

BUDS.

All grosbeaks are usually thought to feed much on buds, and none of the species are believed to be more fond of them than the rosebreast. Most writers have commented on this habit of the rosebreast, and it is referred to also by many correspondents. However, buds were found in but 2 of the stomachs examined, while flowers of trees were found in 4, and it is quite possible that more of the records of field observers relate to flowers than to buds. Among trees whose buds are said to be devoured are beech, cherry, pear, wild plum, soft maple, box elder, and elm. Apparently some of these are greatly relished. G. E. Atkinson, of Ontario, says:[a]

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[a] Birds of America, III, 1841, p. 210.

> They cut off the buds [of beech] close to the twig, eat the soft pip, and drop the shells. On May 11, I * * * saw three rose-breasted grosbeaks feeding, * * * occasionally darting out at a passing insect. I managed to secure one and its stomach was packed with these buds.

The practical significance of the rosebreast's budding has been the subject of widely varying opinions. Seventeen statements concerning the subject are at hand, which, briefly put, are as follows: One author holds the grosbeak injurious; one thinks it may possibly be so; two perceive very little damage; one considers any detriment in this way fully recompensed by the bird's utility in other directions; ten assert that no harm whatever is done, and two declare that budding is beneficial. It will be of interest to cite in full some of these diverse opinions. E. A. Mearns writes:[b]

> Soon after its arrival, the rose-breasted grosbeak appears about our houses, and, possibly, does some damage to the fruit crops by eating the blossoms in the orchards; it is especially fond of those of the cherry, and the rapidity with which it dispatches them is quite marvelous.

H. D. Minot says:[c]

> He * * * eats buds, often committing depredations on our fruit trees; and he must be considered as injurious to agriculture. He frequently plucks blossoms, and, dexterously cutting off the petals, etc., lets them fall, while he retains the ovary which contains the seeds.

Commenting upon the latter author's statement, William Brewster observes:[d]

> There are no good reasons for assuming that this injures the trees or even their crops of fruit. On the contrary, both are probably benefited by the process, which is, in effect, a sort of fruit pruning, seldom if ever more severe than that practiced by the thrifty horticulturists.

It will have been noted that the above quotations refer to flowers, which, as previously stated, seem to be eaten much more commonly than leaf buds. Dr. B. H. Warren found flowers of hickory in 11 stomachs, those of beech in 26, maple in 3, and other blossoms in 23 stomachs collected during May in Pennsylvania. Dr. A. K. Fisher has observed rosebreasts feeding on the flowers of elm and walnut, and during the present investigation flowers of oaks were found in 4 stomachs, the blossoms in two of them being of the post oak (*Quercus minor*). No appreciable damage ensues from the bird's habit of feeding on the flowers of forest trees, since the fruits of these trees are of little economic value. Moreover, it is noticeable that the fruit-producing or pistillate flowers are not the ones preferred, but the sterile staminate ones. These are produced in countless millions, and wither and fall away after a short season. All of the plants named above, whose seeds are even occasionally utilized by man, such as the hickories, walnuts, beech, and oaks, have the staminate and pistillate flowers separate, while no use is made of the seeds of the maple and elm, which have both sexes present in a single flower.

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[a] Trans. Canad. Inst., III (1890–91), 1892, p. 40.

[b] Bright Feathers of North American Birds of Beauty, F. R. Rathbun, 1881, pp. 31–32.

[c] Land Birds and Game Birds of New England, 2d ed., 1895, p. 241.

[d] Loc. cit.

Buds were found in but 2 stomachs, those in one being identified as poplar, and remains of tender young shoots of some woody plant were eaten by another grosbeak. These results indicate a much slighter preference for buds than the bird is usually credited with. But even admitting that the bird relishes buds, it is difficult to conceive how forest and shade trees, numerous as they are, can possibly be injured, since the rosebreast never gathers in large flocks during the budding season. With fruit trees the case is different, for an isolated tree in a home garden may receive the attentions of several birds at the same time. But even then the chance of injury is slight, and in the majority of cases the tree, as stated above, receives no more than a beneficial pruning.

CULTIVATED FRUIT.

The rosebreast is said to feed occasionally on cultivated fruits, but no complaints of serious injury by the bird have been received. Most observers state that they lose but little fruit by grosbeaks, and this is considered only partial payment for services rendered. One correspondent, after mentioning the fact that the birds eat the potato beetle, says:

> They also feed on my berries. Still I plant enough for all, and put up with the loss for the sake of their good qualities.

The rosebreast is reported to attack cherries, currants, and other berries. During the examination of stomachs, however, cultivated fruit was found to have been eaten by only 1 grosbeak. This bird and a companion were collected in a cherry tree in Massachusetts, where they were suspected of pilfering the fruit. One had eaten perhaps a single mouthful of cherry, which constituted 18 percent of its stomach contents, and had eaten also some weevils, stink bugs, and a potato beetle, all highly injurious insects. Several other grosbeaks of the present collection were killed because they were thought to be eating fruit, but their stomachs yielded no trace of it.

WILD FRUIT.

While cultivated fruit is a negligible item of the rosebreasted grosbeak's bill of fare, wild fruit, on the contrary, is the most important single article, constituting 19.3 percent, or almost a fifth of the total food. Many different kinds of fruit are eaten, among which elderberries are probably of most importance. Both the common sweet elder (*Sambucus canadensis*) and the red-berried elder (*S. pubens*) were identified. Nineteen birds had eaten these fruits, which often composed from 60 to 90 percent of the stomach contents. In the gizzard of 1 grosbeak were found fully 200 seeds, which means that no less than 40 to 50 berries were taken at one meal. Blackberries and raspberries rank next in preference, 17 birds having eaten them, and they sometimes constitute 80 percent of the food of individual birds.

Mulberries also are relished, the rosebreast often being observed feeding on the wild red mulberry (*Morus rubra*). June berries (*Amelanchier canadensis*, Plate II, fig. 3) were eaten by 3 of the grosbeaks examined, 80 seeds being discovered in 1 stomach. Eight or more of these rather large fruits must therefore have been taken by this bird. Among other wild fruits eaten by the birds examined are wild red and black cherries (Plate II, fig. 1), choke cherry, rough-leaved dogwood (Plate II, fig. 6), wintergreen, checkerberry, red haw, strawberry, supple-jack, and pokeberry (Plate II, fig. 4). In addition to these, authors and correspondents add flowering dogwood (Plate II, fig. 5), juniper, and sour gum.

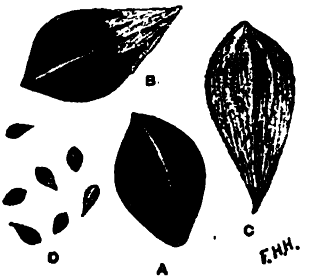

FIG. 21.—Seeds of black bindweed (*Polygonum convolvulus*). (From Hillman, Nevada Experiment Station.)

WEEDS.

Although this grosbeak is not particularly fond of the seeds of weeds, it takes part in the warfare which birds wage against these misplaced plants, and attacks some very troublesome species. Fifteen and three-fourths percent of the bird's food is composed of weed seed, and a greater proportion is consumed in August and September than in other months. The seeds of smartweed and bindweed (fig. 21), species unfavorably known both in country and town, were selected by the greater number of rosebreasts. Those of tumbleweed or amaranth (fig. 18) are next in favor, and when eaten at all almost invariably compose the major part of the stomach contents. These weeds are obnoxious almost everywhere, and their bad qualities are universally acknowledged. Seeds of foxtail (figs. 17 and 37), highly valued in the dietary of many birds, were fed upon by but 2 rose-breasted grosbeaks, and other grass seeds—a small wild oat in 2 cases—were eaten by 4 of the birds examined. Nightshade and sedge seeds were each selected by the same number of birds. The akenes of both common (fig. 6) and giant ragweed were sampled, and the seeds of vervain (fig. 3) and dock are occasionally devoured. Milkweed and sunflower are added to this list by other writers.

MISCELLANEOUS VEGETABLE FOOD.

The rosebreast feeds upon some vegetable matter which does not fall into any of the previously discussed categories. Seeds of the touch-me-not and blood-root, plants widely known for their flowers, are examples. Each was eaten by 1 individual, and 1 fed upon red-bud seeds also, which constituted 80 per cent of its stomach contents. The spiny, globe-like fruits of the sweet gum (*Liquidambar styraciflua*) are bitten into occasionally, but the remains found in the stomach so resemble another but unknown substance that it was possible to identify them certainly in only one instance, and then by means of the very characteristic fertile seeds. The pendent sycamore balls are sometimes rifled of their seed, as also are the aments of alder and birch.

Among the objects most puzzling to classify economically are the curious excrescences of plants, known as galls. These, as is well known, are nurseries for insects, within which the larvæ develop. They are eaten by many birds, extensively by some, and in an instance cited by Dr. A. D. Hopkins,[a] turkeys, chickens, and even hogs and cattle fattened on an abundant gall of the black oak, known in Missouri and Arkansas as " oak wheat " or " wheat mast." An analysis accompanies this note which leaves no doubt that the nourishing elements of galls are of vegetable, not animal, origin. Although this may not be true of all galls, such as certain thin-walled kinds made by plant lice in which at the proper stage the bulk of the imprisoned insects exceeds that of the shell, yet generally, no doubt, it is safe to classify galls as vegetable food. This has been done in the case of those eaten by grosbeaks. Nine rosebreasts had eaten galls, but in only one instance did they compose as much as half the food. The galls eaten appeared to be similar to the spherical species common on oaks.

ANIMAL FOOD.

Animal food, consisting almost exclusively of insects, composes 52 percent of the food of the rose-breasted grosbeak. Nearly 36 percent is beetles, 3.82 percent caterpillars, 6.43 percent Hymenoptera, and 2.38 percent scale insects, the remainder (about 3.33 percent) being made up from several other groups of invertebrates. While the rosebreast feeds upon a large number of formidable insect pests, it devours some beneficial species also. The latter are accorded prior consideration.

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[a] Proc. Ent. Soc. Wash., V, 1903, pp. 151-152.

As just noted, almost 6.5 percent of the total food is Hymenoptera, and as this group contains some of the most useful of all insects, it must be ascertained how many, if any, of these forms fall a prey to the bird. The beneficial Hymenoptera are the small parasitic species, the eggs of which are deposited in the bodies of caterpillars and in the eggs of many insects, to develop there and later destroy their hosts, and the larger wasps, which store up caterpillars and other creatures as food for their young. Very few parasitic species were found in the stomachs, the larger Hymenoptera apparently being preferred. In many cases a single wasp composed from 40 to 90 percent of the stomach contents of individual grosbeaks. It is possible that among these are some of the highly beneficial solitary wasps, but the probabilities are that most of them belong to the more abundant, gregarious species, which although often beneficial would lose little by the destruction of few of their number.

Fifty-four of the 176 grosbeaks examined were found to have eaten Hymenoptera of some sort, which shows that the bird has a decided liking for these insects; but, as just mentioned, few beneficial species are eaten, while a number of injurious ones are devoured. One grosbeak secured a cuckoo fly (*Chrysis* sp.), which is a parasite of the useful solitary wasps. Three fed upon sawfly larvæ, which have habits like caterpillars, and are injurious to roses, currants, pear, willow, and other plants. One bird when collected had 10 sawfly larvæ in its beak, which it was probably gathering for its young; while in the stomach of another grosbeak were 24 of these larvæ, which constituted 60 percent of the contents. The few ants taken are injurious, especially those of the genus *Camponotus*, which sometimes devour the wood of living trees, hollowing them out to mere shells. Two rosebreasts ate little mining bees (*Andrena*), one consuming 26 of these and nothing else. They have no special economic significance except as carriers of pollen.

Passing now to beetles, this grosbeak was found to prey upon members of three useful families, the ground-beetles (Carabidæ), ladybirds (Coccinellidæ), and fireflies (Lampyridæ). Seven birds ate predaceous ground-beetles, but since they compose only a little more than 0.5 percent of the food from May to September, little harm is done. One of the 7 grosbeaks captured a large shining black ground-beetle (*Pasimachus depressus*), which is about an inch in length and is one of the most powerful insects of the family.

Three birds ate coccinellid beetles, one securing a twice-stabbed ladybird (*Chilocorus bivulnerus*), a noted enemy of scale insects. If many such beetles were eaten, damage would be done, but as they compose less than 0.2 percent of the total food, it is evident that only occasionally one is snapped up. Moreover, the grosbeak compensates for any injury done in this way by feeding upon the prey of these beetles—the scale insects.

Fireflies, which are predaceous both in the larval and adult stage, are constantly fed upon by grosbeaks. These insects are supposed to be excellent examples of protected species, having the power of secreting nauseous juices, while the " fire " is supposed to act as a warning signal and certify the bearer's identity to its enemies. It is said that some birds refuse them. However, since 28 rose-breasted grosbeaks fed upon them and 6 to 12 of the beetles were found in single stomachs, they must be relished by this species at least. Fireflies prey upon many important agricultural pests; hence the destruction of any considerable number of them is a loss; and while but 2.71 percent of the grosbeak's food consists of these useful beetles, the bird is chargeable with a distinctively injurious habit.

Thus far only a fourth of the rosebreast's animal food has been discussed. Less than half this amount, or only about a tenth of the total animal matter, is made up of beneficial insects whose destruction is a loss to man. The remaining nine-tenths consists in part of insects of neutral import, but mostly of positively injurious species.

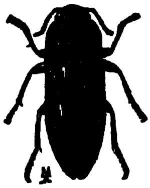

FIG. 22. — Pine buprestid (*Chalcophora virginiensis*). (Marx del. Bureau of Entomology.

Included in the latter category are the bronzy wood-borers (Buprestidæ), among the most serious pests to fruit and forest trees. The larvæ, known as flat-headed borers, do the mischief, often killing trees by completely girdling them just under the outer bark. The adults are incased in a glittering coat of hardest mail, and although they expose themselves on flowers and leaves or on the limbs of trees, they are not fed upon to a marked degree by most birds. The rose-breasted grosbeak, however, seems to relish them, 3.02 percent of its food being composed of these well-protected beetles. The larger species are sometimes captured, one grosbeak having obtained the bulky buprestid *Chalcophora virginiensis* (fig. 22), which is very destructive to pines. This species is an inch in length and as firm and hard as a nut. Smaller species of another genus (*Dicerca*, including *D. obscura*), which feed on hickory and other deciduous trees, also are devoured. Many others not identified were eaten by the 26 grosbeaks which secured buprestids, and the rosebreast must be characterized as one of the important enemies of these beetles.

Resembling the buprestids in compact build and equaling them in evil qualities are the click-beetles (Elateridæ), the larvæ of which are commonly known as wireworms. Their attacks on meadow-grass, grains, and strawberries are of annual occurrence, and result in much damage. Twenty-three grosbeaks, or about one-seventh of the number examined, devoured click-beetles, thus benefiting the farmer considerably.

Not so many of the birds fed upon long-horned borers, but the resulting benefits are less valuable only in degree, as the beetles of this family are often disastrous pests. They are frequently large and strikingly colored, and one of the handsomest, as well as the most injurious kinds, the painted hickory borer (*Cyllene pictus*) is eaten by the rosebreast. This insect is known as the commonest and most destructive pest of the hickory. Another borer also (*Phymatodes varius*), which lives in dead wood, and which is sometimes injurious to the tanbark industry in the South, is devoured.

The rosebreast shows particular fondness for large beetles, a taste readily gratified among the lamellicorn or scarabæid beetles. Among these larger species, beetles of the genus *Dichelonycha*, which feed upon flowers and sometimes are destructive to cultivated plants, were eaten by 9 rosebreasts. Six ate cetoniids (*Euphoria fulgida*, et al.), which are especially adapted for feeding on flowers, and which also at times turn their attention to fruit and the tassels, silk, and young grains of corn. The beautiful and bulky goldsmith beetle, about three-fourths of an inch long, is captured occasionally, and for this service the bird is to be commended, as sometimes the larvæ are very destructive to strawberries. A white grub or larva of a june-bug was the plump morsel obtained by another grosbeak. The ravages of this beetle in lawns and strawberry plots are well known. The bird feeds also upon another good-sized scarabæid (*Anomala binotata*), which injures grapes and other plants.

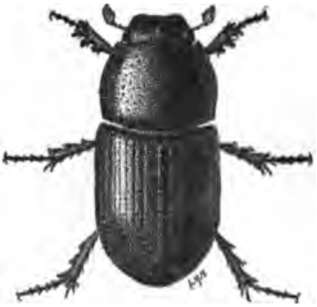
FIG. 23.—Seed corn scarabæid (*Aphodius granarius*). (From Forbes, Illinois Experiment Station.)

Among the smaller members of this family the dung beetles, which occur in large numbers, flying near the ground along country roads, are frequently captured by this grosbeak. Most of them are of neutral economic position, but one species (*Aphodius granarius*, fig. 23), burrows into sprouting corn. Having this bad habit, the farmer is indebted to the grosbeak for preying upon it.

Passing to a group of beetles, the weevils, which are an important element of the food of most birds, and which are so uniformly injurious that almost any one of them may be deemed a pest, it is gratifying to note that the rosebreast does its share toward checking them. Moreover, among the kinds it eats is one of the very worst enemies of cultivated fruit in the United States, namely, the plum curculio (*Conotrachelus nenuphar*, fig. 24). One grosbeak devoured three of these destructive weevils, which may be taken as indicating that an opportunity to feed on them is not overlooked. In this connection it is of interest to recall the other birds that are known to prey upon this pest. They are 8 in number: Great-crested flycatcher, Baltimore and orchard orioles, yellow-throated vireo, bank swallow, veery, hermit thrush, and bluebird. The grosbeak does not confine itself to the plum curculio, but evinces a taste for related species, two of which were identified. These infest the hackberry and hickory, respectively. A fourth kind was present in the stomachs, but could not be assigned a specific name. The curculios destroy a large proportion of the fruit of the trees they attack, and are capable of doing vast damage; hence the services of the birds that devour them are of great value.

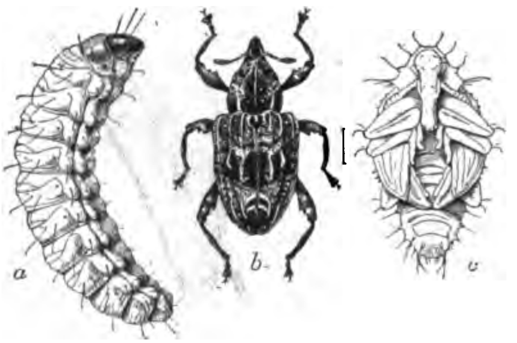

FIG. 24.—Plum curculio (*Conotrachelus nenuphar*). (From Chittenden, Bureau of Entomology.)

Related to the curculios are the nut weevils (*Balaninus*), which attack their favorite plants in much the same way, and often ruin the crop of nut-bearing trees. Six grosbeaks ate from 1 to 3 each of these weevils, one bird capturing 2 acorn weevils (*B. nasicus*). Another curculionid (*Hylobius pales*), which feeds both in living pine trees and pine logs, is included in the grosbeak's diet, and a weevil (*Ampeloglypter sesostris*), which infests the Virginia creeper, was highly relished by an Illinois rosebreast, 11 being eaten, which constituted 74 percent of the stomach contents. Others in the same group are consumed, as many as 4 or 5 being eaten by individuals of the more than 20 birds which fed upon them.

A second family of weevils, the scarred snout-beetles, also contributes to the fare of this grosbeak, and four of them composed 87 percent of the food of one bird; while another rosebreast, one of four which fed upon clover weevils (*Sitones*), captured 13. Billbugs (Calandridæ) are represented in the bird's diet by the conspicuously red and black colored snout-beetle (*Rhodobaenus 13-punctatus*), common on thoroughwort (*Eupatorium*). A weevil of yet another branch of the suborder is sometimes devoured, namely, the peculiar brenthid (*Eupsalis minuta*), a very slender weevil which bores into living oak. Altogether weevils constitute 3.64 per cent of the rosebreast's food, in which amount are included several great pests; hence the bird's weevil-eating propensities result in much benefit to man.

There remains for consideration the family of beetles which contributes most largely to the grosbeak's subsistence, namely, the leaf-beetles (Chrysomelidæ). This family, as an item of food of the rosebreast, is not only most important among beetles, but is only second among both animal and vegetable items. In it are included a number of pests preyed upon by the bird, such as the striped and spotted cucumber beetles, the strawberry rootworm, the plum leaf-beetle, the locust leaf-miner, and in addition that pest which figures so largely in any discussion of the economic value of the rose-breasted grosbeak, the notorious Colorado potato beetle (fig. 25).

The original home of this insect was in Mexico and the Rocky Mountains, where it fed upon the sand-bur (*Sòlanum rostratum*), a plant closely related to the potato. Finding a new and abundant supply of food in the cultivated potato, the beetle immediately began to multiply and to migrate eastward, spreading from 1850 to 1874 over the northern half of the eastern United States. As it encountered practically no enemies in its new home it became so abundant and inflicted so great damage that successful cultivation of potatoes seemed no longer possible. However, just as the beetle found a new food, so it in turn became new food to a number of mammals, birds, and insects, and presently the farmers learned to destroy it in large numbers with poisons. Hence it is no longer greatly dreaded, though in most sections constant vigilance must be exercised to prevent it from ruining the crop.

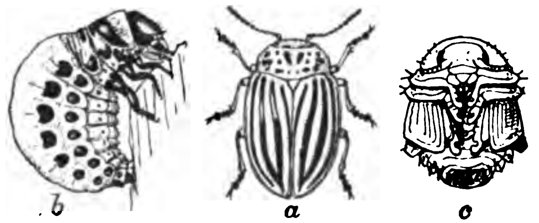

FIG. 25.—Potato beetle (*Leptinotarsa decemlineata*). (From Chittenden, Bureau of Entomology.)

Naturally during the period when the beetle was doing most damage everyone was on the lookout for means of checking its increase, and the discovery of each new natural enemy was heralded far and wide. Attracting most notice among these was the rose-breasted grosbeak, and many articles were written calling attention to the newly discovered trait of this beautiful bird. It should be noted also that several other birds, including the bobwhite, prairie chicken, sharp-tailed and ruffed grouse, red-tailed hawk, nighthawk, cuckoo, crow, English sparrow, cardinal, scarlet tanager, wood, hermit, and olive-backed thrushes, and robin, eat potato beetles occasionally.

The grosbeak's habit of feeding on the potato beetle was noted almost simultaneously in many localities, and references are at hand for the States of Missouri, Iowa, Minnesota, Wisconsin, Illinois, Michigan, and Ohio. The rosebreast actually exterminated the potato beetle in many patches it patrolled. Mr. W. F. Bundy,[a] who was among the earliest to write upon the subject, says:

> I noticed last summer that great numbers of the Colorado potato beetles were destroyed by the rosebreasted grosbeak. * * * They were so abundant in this region [Jefferson, Wis.] * * * as to hold in check the vast army of these ravagers of the potato crop.

The beetles are attacked as soon as they emerge from their winter quarters, according to Mr. J. S. Cook,[b] of northern Illinois, who says:

> I have seen them so gorge themselves with these beetles that they were scarcely able to fly. I have investigated in the spring, when the beetles first came out of the ground, and was unable to find a single one after following these birds.

Further testimony to the value of the bird is given by Prof. F. E. L. Beal,[c] who watched the grosbeaks and their young feeding upon the potato bugs in his garden at Ames, Iowa:

> When a careful inspection was made a few days later not a beetle, old or young, could be found; the birds had swept them from the field and saved the potatoes.

Comparison of the dates of the first appearance of the Colorado beetle with the earliest records when the rose-breasted grosbeak fed upon it shows that from six to ten years passed before the bird commonly began to prey upon the insect. Even after the lapse of so much time it was one of the first enemies of the beetle noted and by far the most important among birds.

The results of stomach examinations fully corroborate the testimony of field observers as to the extent to which the rosebreast feeds upon this beetle. Forty-three, or almost one-fourth of the birds examined, fed upon the potato beetle to such an extent that the insect makes up 9.05 percent of the subsistence of the entire number and nearly 35 percent of that of the individuals eating it. The significance of these figures will be better appreciated when it is considered that the potato beetle probably was not obtainable by many of the grosbeaks, and furthermore, that it is very unusual for birds to prey so extensively upon a single kind of insect, or even on the species collectively of a whole group. Such concentration of attack of a common bird upon a single species of insect, however numerous, can not but have a restraining influence on its numbers. The beetle is fed upon from May to September and both larvæ and adults are devoured, 10 to 14 being found in single stomachs. By feeding upon the larvæ the rosebreast directly benefits the potato plants, and by destroying adults the increase of the species is checked.

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[a] Am. Nat., IX, 1875, p. 375.

[b] Trans. Ill. Hort. Soc., 37 (1903), 1904, pp. 331–332.

[c] U. S. Dept. Agr., Farmers' Bul. 54, 1904, p. 35.

Although the potato beetle is the worst pest in the Chrysomelidæ, this family contains other serious enemies of crops. The rosebreast feeds upon several of them, thereby further commending itself to our esteem. Both the small striped and the spotted cucumber beetles (fig. 26), which are abundant and injurious over much of the United States, are consumed. The importance of the bird's inroads upon one of these little black and yellow species, which in the larval stage is the destructive corn root-worm, is emphasized by the fact that no direct method of combating the insect has yet been devised. Twelve grosbeaks fed upon these beetles, as many as 7 being found in a single stomach. Further evidence of the bird's strong preference for them is furnished by Mr. Ridgway, who observed a number of rosebreasts feeding exclusively on spotted cucumber beetles in a locality where the latter were very abundant.

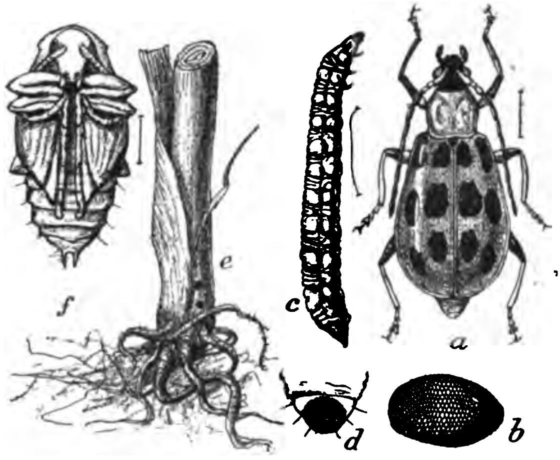

FIG. 26.—Spotted cucumber-beetle (*Diabrotica 12-punctata*). (From Riley and Chittenden, Bureau of Entomology.)

Ten of the grosbeaks examined had eaten another kind of leaf-beetle (*Melasoma lapponica*), which feeds on willows and poplars, sometimes working havoc by defoliating trees, especially in windbreaks. These beetles appear to be much relished, as from 10 to 27 were taken by individual rosebreasts, of whose food they composed from 60 to almost 100 percent. Two or three other species of Chrysomelidæ, injurious to willows, to grapes, and to garden crops, are devoured. Nine birds ate beetles of one of these species (*Calligrapha bigsbyana*), which in individual cases constituted 70 per cent of the stomach contents. The rosebreast devours also two Hispid leaf-beetles, one of which causes considerable injury. This is the locust leaf-miner (*Odontota dorsalis*), which sometimes devastates whole groups of trees, leaving them as if scorched by fire. Eight grosbeaks had eaten leaf-miners, and in one case 8 were consumed by a single bird.

The long list of beetles of this family that are preyed upon by the rosebreast is completed by the strawberry root-worm (*Typophorus* *canellus*), which at times is very destructive, the plum leaf-beetle (*Nodonota tristis*), which causes dropping of cotton bolls, a species (*Griburius equestris*) which feeds on wild roses, and another wildflower beetle (*Cryptocephalus quadrimaculatus*).

With the Chrysomelidæ is concluded also the list of principal Coleopterous families. The grosbeak eats few others. One rosebreast devoured 5 of the decidedly malodorous burying beetles (*Silpha noveboracensis*), which feed on carrion, while another captured one hard, polished *Hister*, an insect of similar habits. Sixteen of the little orange and black *Ips fasciatus* were secured by one of the three birds which fed upon this occasional depredator of stored vegetables and grain.

It thus appears that a large number of the beetle enemies of agriculture are preyed upon by the rose-breasted grosbeak. An almost equal array of serious pests is secured from the ranks of another order, which is eaten to only one-ninth the extent that beetles are, namely, the moth and butterfly order or Lepidoptera.

This group may be discussed conveniently under the heads "larvæ" and "adults." The latter do not seem to be eaten to any great extent by birds, and only 2 rosebreasts fed upon them. Four moths were secured, but they composed less than 0.2 percent of the total food. The larvæ or caterpillars, however, are more generally relished by birds and often are eaten in large numbers. Twenty-two out of the 176 rosebreasts had eaten caterpillars, some of them securing from 6 to 14 each, which usually constituted from 50 to 85 percent of the stomach contents. They make up 3.82 percent of the entire food of all the rosebreasts examined.

It is well known that at times the depredations of lepidopterous insects, such as canker worms, tent caterpillars, gipsy moths, and many others, are very serious, threatening ruin to orchards and even large forests, and thus becoming of State, if not National, importance. The difficulties encountered in combating such pests render the aid of natural enemies most valuable. It should be widely known that the rose-breasted grosbeak is conspicuous among the enemies of these insects, and also that it feeds upon no fewer than eight of the very worst lepidopterous pests.

Among the more widely known of these are the canker worms, which are very destructive to both orchards and woodlands. They often strip orchards so that they appear as if fire swept, and when their attacks are continued for a few years the trees die. The rose-breasted grosbeak devours both the spring canker worm (*Paleacrita vernata*, fig. 35) and the fall canker worm (*Alsophila pometaria*, fig. 27). Two birds collected in Illinois in May had fed upon the former caterpillar, while O. W. Knight testifies that in Pleasant Valley, Me., the birds actively attack the other.

The dreaded army worm (*Heliophila unipuncta*, fig. 28), which sometimes appears in myriads and devastate fields of grain and grass, also is the prey of this beautiful grosbeak. A bird from Illinois in July had captured 6 of these destructive caterpillars.

The tent-caterpillars are another group of noxious lepidopterous insects, which are common in many parts of the United States. They greatly damage orchards, as well as shade and woodland trees. E. H. Forbush[a] is authority for the statement that the rose-breasted grosbeak preys upon the orchard tent-caterpillar (*Malacosoma americana*, fig. 29), and Prof. C. M. Weed[b] reports that the bird devours moths, larvæ, and pupæ of the forest tent-caterpillar (*M. disstria*).

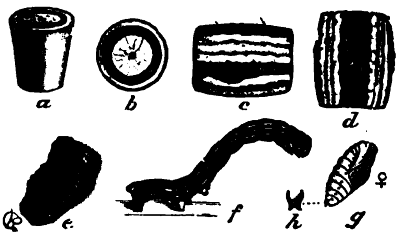

FIG. 27.—Fall cankerworm (*Alsophila pometaria*). (From Riley, Bureau of Entomology.)

Two other insects of this order, which are usually thought of together and which indeed are closely related, are the gipsy moth (fig. 30) and the brown-tailed moth (fig. 31). Mere mention of their names calls to mind the enormous damage done by them in the State of Massachusetts, and of the costly efforts being made to stamp out these disastrous invaders from across the sea. Birds have proved of service as allies in this struggle, and the present species is by no means least in importance among them. In the original report[c] on the gipsy moth, as well as in later publications,[d] the rosebreast is listed among the species devouring the larvæ, while in regard to the brown-tail moth Messrs. Mosher and Kirkland report[e] that "a rose-breasted grosbeak ate 57 caterpillars in twenty minutes."

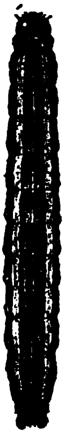

FIG. 28.—Army worm (*Heliophila unipuncta*). (From Chittenden, Bureau of Entomology.)

This species eats hairy and spiny caterpillars as readily as smooth ones, and the idea so often advanced that such hairy armature is effective protection against the attack of birds receives little support from the food habits of the grosbeaks. Tussock and gipsy moths and both of the tent caterpillars are devoured, though very hairy. The browntail, the hairs of which so irritate human flesh, also is eagerly eaten, and other caterpillars clothed with spines were found in the stomachs examined. In several gizzards, indeed, a mass of branching caterpillar spines was all that remained to show the nature of the food. It is evident that neither hairs nor even pricking, stinging spines are adequate to protect a caterpillar from a hungry grosbeak.

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[a] Mass. State Bd. Agr. Rep. (1900), 1901, p. 315.

[b] N. H. Exp. Sta. Bull. 75, 1900, p. 121.

[c] Forbush, E. H., and Fernald, C. H., The Gipsy Moth, 1896, p. 219.

[d] Forbush, E. H., Mass. State Bd. Agr. Rep. (1900), 1901, p. 313.

[e] Forbush, E. H., Mass. State Bd. Agr. Rep., 1899, p. 322.

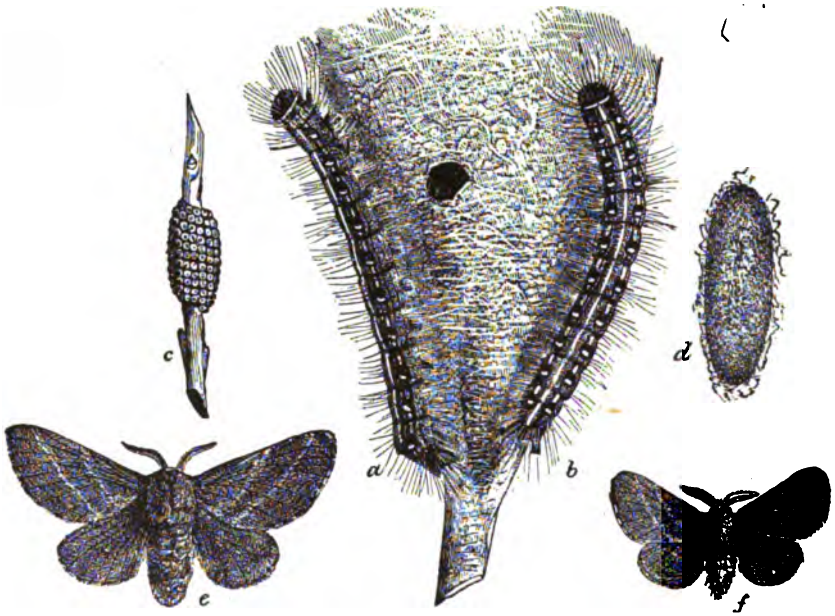

FIG. 29.—Orchard tent-caterpillar (*Malacosoma americana*). (From Riley. Bureau of Entomology.)

Besides Hymenoptera, Coleoptera, and Lepidoptera, which have been discussed in the order named, but one group of insects of importance in the dietary of the rosebreast remains, that of true bugs (Hemiptera), including the stink bugs, tree hoppers, plant lice, and scale insects. From this miscellaneous assemblage the grosbeak selects 3.89 per cent of its food, and two-thirds of this amount consists of the minute pests known as scale insects. From an economic standpoint also the latter are of greatest importance, as they rank among the worst enemies of agriculture in the United States. Orchards, both of the deciduous and citrus

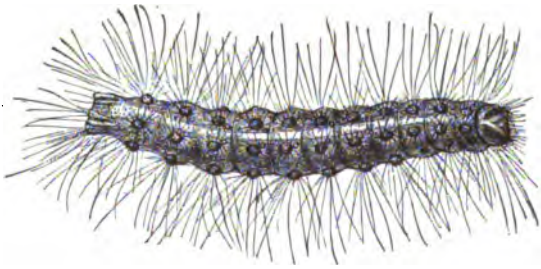

FIG. 30.—Gipsy moth caterpillar (*Porthetria dispar*). (From Bureau of Entomology.)

fruits, are most seriously affected, while shade and forest trees also suffer greatly.

Thirty-three of the rosebreasts examined had eaten scale insects, four kinds of which were identified. The plum scale (*Eulecanium cerasifex*), which is an occasional pest on cherry, apple, and pear, besides the tree from which it is named, seems to be relished. A female grosbeak collected in Indiana in May had consumed 36 plum scales, which constituted 95 percent of its food. Of two birds from Illinois, one ate 45 and the other more than 100 scales of this species, which composed 95 and 100 percent, respectively, of their stomach contents. Two nearly related species, the hickory scale (*E. caryæ*) and the tulip scale (*E. tulipiferæ*), which latter sometimes seriously injures shade trees, also are devoured. Eleven grosbeaks ate unidentified species of the same genus of scale insects; two preyed upon the oak scale (*Kermes*), while the stomachs of 15 birds contained scale remains which defied determination.

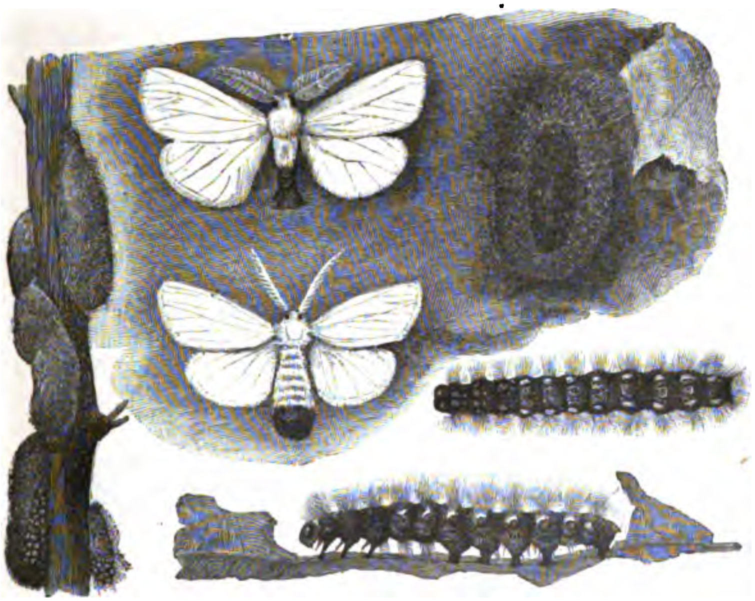

FIG. 31.—Brown-tail moth (*Euproctis chrysorrhoea*). (From Howard, Bureau of Entomology.)

The fact that birds exert a restrictive influence upon scales has remained almost unknown, these small insects being considered well protected from feathered enemies by their minute size and waxy secretions. Hence little attention has been paid to the subject, and the accounts of a few writers who announced the true relations of birds to scales were overlooked or ignored. Recent investigations have shown that many of our birds eat scales. The rose-breasted grosbeak is prominent among them, both because it eats a maximum number of species and because at times it makes scales a considerable part of its fare. These little pests can not have too many enemies for the good of mankind, and every bird that preys upon them should be welcomed and protected.

The rosebreast sometimes feeds upon plant lice (Aphididæ), especially those that live on birch; and a number of these fragile insects were found in a single stomach. Among other bugs, the odd little buffalo tree-hopper (*Ceresa bubalus*, fig. 32), and a few of the flower-bug and squash-bug families were found. Eight grosbeaks ate members of the stink-bug family. In feeding upon these insects the rosebreast gives further evidence of its indifference to flavors and odors which to us are repulsive and nauseating in the extreme. Two of the birds examined had devoured specimens of the banded soldier bug (*Milyas cinctus*), which preys upon many insects, including the potato beetle, and of another assassin bug (*Sinea diadema*), which preys upon cankerworms and other caterpillars, besides flies and bees, including the honey bee. Were the habit of devouring such bugs general, injury would result, but fortunately it is not. According to B. F. Gault, the rosebreast feeds upon the chinch bug, which at times has proved the worst crop pest in the country.

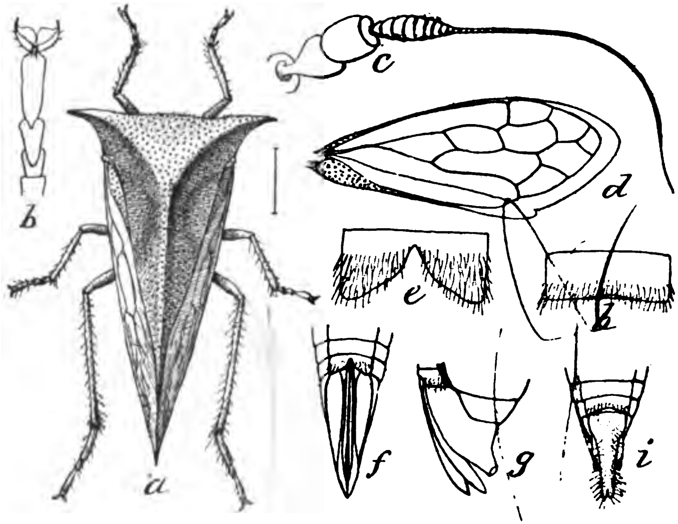

FIG. 32.—Buffalo tree-hopper (*Ceresa bubalus*). (From Marlatt, Bureau of Entomology.)

A remarkable feature of the rosebreast's dietary is the few grasshoppers eaten. These nutritious insects, which are welcomed by almost all birds, compose only 0.2 percent of the food of the whole number of grosbeaks examined. Results from the present collection of stomachs may not represent a fair average, but as proportionate numbers of the individuals examined were secured in the grasshopper season the data indicates at least a well-defined tendency of the bird to neglect them. That it does not actually dislike grasshoppers there is sufficient proof, for John Bachman wrote to Audubon[a] that a caged specimen "ate grasshoppers and crickets with peculiar relish," and Samuel Aughey[b] examined two specimens collected during one of the historic invasions of the Rocky Mountain locust, each of which "had about a dozen of locusts in its stomach."

Comparatively little weight, however, attaches to these instances, since the conditions were unusual. It is worthy of note that the closely related blackheaded grosbeak similarly neglects grasshoppers. Four rosebreasts fed upon this class of insects, 2 securing the peculiar shield-back grasshoppers, in one case to the number of 6, which composed 85 percent of the stomach contents, while the other 2 birds had eaten an ordinary grasshopper and an orthopterous insect not identified.

The small quantity of animal matter not yet detailed comprises spiders and their egg-sacs, which were eaten by 3 grosbeaks, and insect eggs and a fly by 1 each. Only 1 bird of this species had eaten a snail, which indicates that the rosebreast cares less for this kind of food than does the cardinal.

MINERAL MATTER.

Mineral matter, estimated in relation to the entire stomach contents, averaged 6.3 percent. Besides the ordinary sand and fine gravel, fragments of fossil corals and crinoids had been utilized for grinding material.

NESTLINGS.

Of the total number of birds only 4 were young still being fed by their parents, but, as usual among species whose diet is mixed, the proportion of animal food to vegetable is much greater in the case of fledglings than of adults. These 4 young rosebreasts consumed 78 per cent of animal and 22 per cent of vegetable matter. The 2 that were out of the nest were more highly vegetarian, one having eaten 85 per cent of plant substances. The latter were a berry of rough-leaved dogwood, some blackberries, of which 45 pits were present, and a few other seeds. Of the animal food consumed by the 4 young birds, caterpillars compose 20 percent, among them being the larvæ of sphinx moths, most of which are injurious to agriculture. Almost 25 percent is composed of beetles of various families, including bronzy wood-borers, click-beetles, and leaf-beetles. Representing the last family are the species *Melasoma lapponica*, which injures willow and cottonwood windbreaks, and that noted pest the

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[a] Audubon, J. J., Birds of America, III, 1841, p. 211.

[b] First Ann. Rept. U. S. Ent. Comm., 1878, App. II, p. 32.

Colorado potato beetle. Two stomachs of nestlings contained this latter nauseous insect, larvæ being found in one, adults in another. Wasps composed almost half of the food of one fledgling, and a weevil and some small cocoons constituted the remaining animal matter.

Passing from these results of actual stomach examination to the experiences of observers, it should be noted that the rosebreast's habit of feeding its nestlings the larvæ of the potato beetle is frequently recorded. This fact is one of the best evidences of the importance of this beetle in the grosbeak's regimen. Prof. F. E. L. Beal[a] speaks of "a small potato field, which earlier in the season was so badly infested * * * that the vines were completely riddled. The grosbeaks visited the field every day, and finally brought their fledged young. The young birds stood in a row on the topmost rail of the fence and were fed with the beetles which their parents gathered." Prof. E. F. Hitchings, State entomologist of Maine, gives the following interesting note:

> Several years ago I observed a pair nesting in a clump of trees in * * * Waterville. A piece of potatoes was planted near by, and I watched the parent birds as they fed their young on the larvæ of the Colorado potato beetle. I examined the bills of the young and found them stained and even dripping with the juice of the insects. It took a great many young larvæ to satisfy them. (May 19, 1906.)

When we reflect that every year there are thousands of grosbeak families throughout the breeding range of the species doing exactly the same thing, it can not be doubted that they exert a marked effect on the numbers of the potato beetle.

The voracity of nestlings is proverbial, and their lusty appetites greatly enhance their value as destroyers of injurious insects. The number of insects eaten daily by nestlings has been recorded in the case of but few birds; hence we are fortunate in having E. H. Forbush's account of a study of the nestlings of the rosebreast:

> On June 12, 1899, Mr. Mosher watched the nest of a pair of rose-breasted grosbeaks from early morning to 5 p. m. * * * For the first half hour the old birds were so excited by his presence that the feeding of the young birds was interrupted, so that no notes were taken until 6 a. m., and none were taken after 5 p. m. The old birds visited the nest—

	Times.		Times.
Between 6 and 7	52	Between 12 and 1	32
Between 7 and 8	47	Between 1 and 2	38
Between 8 and 9	43	Between 2 and 3	41
Between 9 and 10	30	Between 3 and 4	22
Between 10 and 11	36	Between 4 and 5	58
Between 11 and 12	27		

> making altogether 426 visits during the portion of the day that they were watched. The food was mainly caterpillars of one kind or another, and there

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[a] Farmers' Bull. 54, 1904, p. 35.

were only four visits made by a parent bird when but one insect was fed to the young; they usually brought three or more. A bird often carries in this way from three to eleven or twelve small caterpillars in its mouth and beak at one time. Owing to the height of the nest above the ground, it was impossible to determine accurately the species of caterpillars brought to the young. A considerable portion of them were certainly leaf-rollers from the oak trees. It seems probable, then, that these two birds must have fed their young on that day at least 1,000 insects, mostly caterpillars. This certainly is a very moderate estimate of the number of insects destroyed in one day by the family when we take into consideration the food required by the old birds.[a]

Although in this particular instance the precise nature of the food was not ascertained, there is much evidence to show that the same pests are fed to the young which are eaten by adults.

SUMMARY.

Examinations of 176 stomachs of rose-breasted grosbeaks show that the food is composed of animal and vegetable matter in almost equal parts, the exact proportions being 52 and 48 percent, respectively. Of the portion of the diet gleaned from the plant kingdom, 5.09 percent is grain, 1.37 garden peas, and 19.3 wild fruit. A third of the grain eaten may possibly be pillaged from standing crops, but this is the only stage when injury by birds is not easily prevented. Even if the total amount of grain consumed is pilfered from cultivated fields, it does not warrant hostile acts against a bird otherwise so beneficial.

Wild fruit is greatly relished, but cultivated fruit is not damaged, and although budding is practiced to a certain degree practically no harm results.

The rosebreast preys to some extent upon such beneficial insects as parasitic Hymenoptera, ground beetles, ladybirds, and fireflies. Only a tenth of the animal food is of this character, however, while among the remaining nine-tenths, which consists almost exclusively of injurious insects, is included a large number of formidable pests. Among these are the cucumber beetles, the hickory borer, plum curculio, Colorado potato beetle, Rocky Mountain locust, spring and fall cankerworms, orchard and forest tent-caterpillars, tussock moth, army worm, gipsy and brown-tailed moths, and the chinch bug. The bird is known as an active enemy of the cankerworm and the army worm during their extraordinary infestations, and was among the birds which preyed upon the Rocky Mountain locust and the gipsy moth at the height of their destructiveness.

Few birds have so good record both as to the large number of important pests attacked and the slight amount of damage done.

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[a] Forty-seventh Annual Report Mass. State Board of Agriculture (1899) 1901, p. 325.

LIST OF SEEDS, FRUITS, OTHER VEGETABLE SUBSTANCES, AND INVERTEBRATES EATEN BY THE ROSE-BREASTED GROSBEAK.

CULTIVATED PLANTS.

Corn (*Zea mays*).
Oats (*Avena sativa*).
Wheat (*Triticum vulgare*).
Cherry (*Prunus cerasus*).
Peas (*Pisum sativum*).

WILD FRUITS.

Mulberry (*Morus rubra*).
Pokeberry (*Phytolacca decandra*).
Sweet gum (*Liquidambar styraciflua*).
Blackberry (*Rubus* sp.).
Strawberry (*Fragaria* sp.).
Juneberry (*Amelanchier canadensis*).
Red haw (*Crataegus* sp.).
Wild red cherry (*Prunus pennsylvanica*).
Choke cherry (*Prunus virginiana*).
Wild black cherry (*Prunus serotina*).
Redbud (*Cercis canadensis*).
Supple-jack (*Berchemia scandens*).
Rough-leaved cornel (*Cornus asperifolia*).
Checkerberry (*Gaultheria procumbens*).
Nightshade (*Solanum* sp.).
Sweet elder (*Sambucus canadensis*).
Red-berried elder (*Sambucus pubens*).

BUDS AND FLOWERS.

Cottonwood (*Populus* sp.).
Post oak (*Quercus minor*).

WEEDS.

Green foxtail (*Chætochloa viridis*).
Sedge (*Carex* sp.).
Knotgrass (*Polygonum aviculare*).
Pale persicaria (*Polygonum lapathifolium*).
Pennsylvania persicaria (*Polygonum pennsylvanicum*).
Black bindweed (*Polygonum convolvulus*).
Dock (*Rumex* sp.).
Pigweed (*Amaranthus* sp.).
Bloodroot (*Sanguinaria canadensis*).
Wild radish (*Raphanus sativus*).
Touch-me-not (*Impatiens biflora*).
Dodder (*Cuscuta* sp.).
Blue vervain (*Verbena hastata*).
Giant ragweed (*Ambrosia trifida*).

COLEOPTERA.

Ground-beetles (Carabidæ):
  Pasimachus depressus.
Ladybirds (Coccinellidæ):
  Chilocorus bivulnerus.
  Brachyacantha ursina.
Histeridæ:
  Hister sp.
Nitidulidæ:
  Ips fasciatus.
Click-beetles (Elateridæ).
Bronzy wood-borers (Buprestidæ):
  Chalcophora virginiensis.
  Dicerca obscura.
Fireflies (Lampyridæ):
  Ellychnia corrusca.
  Photinus pyralis.
  Podabrus tomentosus.
  Telephorus bilineatus.
  Telephorus carolinus.
  Telephorus rotundicollis.
Lamellicorn beetles (Scarabæidæ):
  Aphodius fimetarius.
  Aphodius granarius.
  Aphodius inquinatus.
  Dichelonycha elongata.
  Lachnosterna sp.

COLEOPTERA—continued.

- Lamellicorn beetles—Continued.
  - *Cotalpa lanigera.*
  - *Euphoria fulgida.*
- Long-horned beetles (Cerambycidæ):
  - *Phymatodes varius.*
  - *Cyllene pictus.*
  - *Leptura* sp.
- Leaf-beetles (Chrysomelidæ):
  - *Orsodachna atra.*
  - *Cryptocephalus 4-maculatus.*
  - *Griburius equestris.*
  - *Typophorus canellus.*
  - *Nodonota tristis.*
  - *Leptinotarsa decemlineata.*
  - *Chrysomela* sp.
  - *Calligrapha bigsbyana.*
  - *Calligrapha philadelphica.*
  - *Melasoma lapponica.*
  - *Diabrotica 12-punctata.*
- Leaf-beetles—Continued.
  - *Diabrotica vittata.*
  - *Odontota dorsalis.*
  - *Odontota nervosa.*
- Scarred snout-beetles (Otiorhynchidæ).
- True snout-beetles (Curculionidæ):
  - *Sitones* sp.
  - *Phytonomus* sp.
  - *Hylobius pales.*
  - *Conotrachelus albicinctus.*
  - *Conotrachelus juglandis.*
  - *Conotrachelus nenuphar.*
  - *Ampeloglypter sesostris.*
  - *Balaninus nasicus.*
- Brenthidæ:
  - *Eupsalis minuta.*
- Bill-bugs (Calandridæ):
  - *Rhodobænus 13-punctatus.*

HEMIPTERA.

- Tree-hoppers (Membracidæ):
  - *Ceresa bubalus.*
- Scale insects (Coccidæ):
  - *Kermes* sp.
  - *Eulecanium caryæ.*
  - *Eulecanium cerasifex.*
  - *Eulecanium tulipiferæ.*
- Plant lice (Aphididæ).
- Stink bugs (Pentatomidæ).
- Coreidæ.
- Plant bugs (Capsidæ).
- Assassin bugs (Reduviidæ):
  - *Sinea diadema.*
  - *Milyas cinctus.*

ORTHOPTERA.

- Short-horned grasshoppers (Acridiidæ):
  - *Tettix* sp.

LEPIDOPTERA.

- Hawk moths (Sphingidæ).
- Owlet moths Noctuidæ):
  - *Heliophila unipuncta.*
- Span worms (Geometridæ):
  - *Paleacrita vernata.*

HYMENOPTERA.

- Short-tongued bees (Andrenidæ).
- Cuckoo-flies (Chrysididæ):
  - *Chrysis* sp.
- Smooth-headed ants (Formicidæ):
  - *Camponotus* sp.
- Saw-flies (Tenthredinidæ).

OTHER INSECTS.

- Two-winged flies (Diptera).

OTHER INVERTEBRATES.

- Spiders (Araneida).
- Snails (Gastropoda).

BLACK-HEADED GROSBEAK.

(*Zamelodia melanocephala.* Plate III.)

APPEARANCE, DISTRIBUTION, AND HABITS.

In form and size the black-headed grosbeak is almost a counterpart of the last species, but it is very different in color. In the male blackhead, golden brown and lemon yellow take the place of the rose and white of the rosebreast; while the color of the underparts of the female is not soiled white, as in the eastern bird, but bright buffy. Both sexes of the western grosbeak have a horn-colored beak; that of the rosebreast is white.

Occupying a range from the west coast eastward which is complementary to, although slightly overlapping that of its eastern relative, the blackhead occurs from lowermost Mexico to southern British Columbia, northern Montana, western North Dakota, and northeastern Nebraska. It breeds at both extremes, and withdraws in winter to the southern third of its range, lingering as far north, however, as central Mexico.

The male is a brilliant songster, the peer of any of his kin. He is also an excellent mate and parent, and assumes an equal share of the labors of the nesting season. The nests of this species are loosely built and generally are placed in low growth, often along streams. The eggs are 3 or 4 in number and are similar to those of the rosebreast. The young are hatched in May and June. Since the bird often makes its home in higher altitudes it is sometimes called the mountain grosbeak.

ECONOMIC RELATIONS.

So great is the economic importance of the black-headed grosbeak that partial accounts of its food habits appear in two previous publications of the Biological Survey.[a] Only 70 stomachs were then available for examination, while more than three times that number[b] are now at hand, collected in five States and Territories. As the greater number are from California, the present report relates essentially to that State. The stomachs were collected from April to August, inclusive. The data show that about two-thirds of the bird's food consists of insects and other animal matter and one-third of vegetable substances. To be more exact, 65.85 percent is animal, 34.15 vegetable. The maximum amount (79.95) of animal matter is consumed in June. From the standpoint of the agriculturist great interest attaches to the vegetable food of this bird, as it is reputed to be destructive to cultivated fruit.

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[a] Farmers' Bull. 54, 1904, pp. 35–36; Yearbook Dept. Agr., 1904, pp. 246 and 248.

[b] About half of the total number of stomachs of this species were examined by Prof. F. E. L. Beal.

VEGETABLE FOOD.

Wheat and oats constitute but 2.08 and 1.83 percent, respectively, of the total food. Weed seeds and miscellaneous vegetable matter make up 9.28 percent, while fruit exceeds the sum of all these elements, and amounts to 20.96 percent of the entire subsistence, or almost two-thirds of the vegetable portion of the food. Fruit as an item of the bird's food assumes all the more importance because much of it is cultivated.

FRUIT.

Cultivated fruit that can be positively identified averages 9.85 percent of the contents of the 226 stomachs examined, and wild species 6.37 percent. In addition, 2.02 percent consisted of blackberries and raspberries, which may have been either wild or cultivated; 2.72 percent was undetermined fruit pulp of equally doubtful economic significance. It seems certain, therefore, that considerably more than half, perhaps two-thirds, of the fruit consumed by black-headed grosbeaks is from orchards and gardens. As this may be taken from a restricted region in a limited time, the item is of considerable importance in any locality where grosbeaks are numerous.

Moreover, no fruit, however large and tough-skinned, is proof against the massive beak of the blackhead, and the bird is likely to damage a great deal more than it eats because of its habit of leaving fruits after it has taken a single bite. Indeed, many of the fruits it attacks are so large that the bird could not swallow them entire. Apples, crabapples, peaches, apricots, pears, figs, plums, cherries, gooseberries, and blackberries are included in complaints of injury which have been received by the Survey and prunes and strawberries must be added to the number on the evidence of stomach examinations.

According to Professor Beal,[a] in California the depredations by the black-headed grosbeak cause it to be ranked about fourth in importance among fruit-eating birds. What this means will be better understood from account of the actual damage by the species. Prof. A. J. Cook gives the following instance:[b]

> A cherry grower at Ontario, Cal., reports the loss of half of a $4,000 crop of cherries from the depredations of birds in 1898. The birds in order of importance are *Piranga ludoviciana*, *Phainopepla nitens*, and the present species.

E. W. Nelson, of the Biological Survey, writes concerning his acquaintance with this grosbeak at Nevada City, Cal.:[c]

> I was told they were a great pest to fruit growers as they ate and destroyed a great many berries. This I proved by shooting several with their bills stained

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[a] Yearbook Department of Agriculture 1904, p. 246.

[b] California Cultivator, Aug., 1898, p. 253.

[c] Proc. Bost. Soc. Nat. Hist., 17, 1875, p. 359.

> with blackberries and their crops full of them. I saw many of the berries which they had taken one bite from, leaving the rest.

In New Mexico the bird bears no better reputation, according to Jackson Tabor, of Folsom, who says:

> I have found the black-headed grosbeak to be very destructive to all kinds of vegetables and fruits. They made their first appearance in this country in the year 1888, and they came in swarms. * * * They destroyed the entire crop of gooseberries and commenced on crabapples, eating the apples off the top of the tree as I was picking them off the lower limbs. In the spring and early summer they take the cherries as fast as they get ripe, and the only remedy seems to be to wage a war of extermination against them. (September 2, 1903.)

Two stomachs were collected in Mr. Tabor's orchard on this date and both contained fruit, that in one stomach being identified as crabapple.

Following are the results obtained from the investigation of stomach contents: Cherries, both ripe and green, were selected by 41 of the grosbeaks examined, frequently composing from 45 to 95 percent of the stomach contents. All were identified by skins, not a seed being found, showing that the birds here and there bite into a cherry, destroying in this way many more cherries than if they satisfied their appetites by swallowing the fruit entire. Figs were next in order of preference, being devoured by 23 grosbeaks. In some cases they composed from 80 to 100 percent of the food. Among other fruits, remains of plums, crabapples, and apricots were found, each in one stomach, and strawberries in two. Unidentified fruit pulp and blackberries had been eaten by 23 birds. As noted above, it is uncertain whether these were cultivated or not, but probably the bulk were cultivated and should be charged against the bird.

Thus far our investigations have revealed nothing but injury by the bird, but, as will be shown later, the blackhead is not exclusively an enemy.

PROTECTIVE METHODS.—In connection with this subject there remains to be considered possible methods of reducing or altogether preventing loss from depredations by these birds. The plan usually suggested is the one mentioned in the above letter of Mr. Tabor, namely, "a war of extermination." This is generally effected by poisoning or shooting.

Aside from the fact that the justice of this method is open to serious question, there is the greater objection that innocent species often suffer equally with or even in greater degree than the marauder. In illustration we quote from Frank Stephens:[a]

> At Beale Spring both sexes were common and destroying quantities of fruit, to the great annoyance of the owner of the orchard, who employed an

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[a] Condor, V, 1903, p. 103.

Indian to shoot the birds. Unfortunately the Indian did not discriminate between the noxious and harmless species.

When poisoning is resorted to as a means of defence the destruction of many beneficial birds is inevitable. Nevertheless, if the above methods are condemned the fruit grower is entitled to ask for an effective substitute. A device for the protection of a small number of trees, which can be applied on rather short notice, is bird netting. This was tested upon cherry trees some years ago at the Indiana Agricultural Experiment Station.[a] The netting was procured at a cost of 4 cents per square yard and 75 yards were required per tree, the latter having been set six years. The fruit produced in a single season paid for the netting, which with careful handling, it is said, will last for ten years or more. This method is practicable in the case of a few lawn or garden trees, or possibly even in small orchards, and is well worth trial by anyone who considers future as well as present fruit crops. For it is certain that in destroying grosbeaks we end the lives of creatures which do much to check serious insect enemies of fruit. In large orchards netting of course can not be used.

Killing the grosbeaks is a last resort to be tried only when every other measure has been tested and failed. It is the less excusable because a method is available which, even in the case of large orchards, yields far better results. This is the planting here and there of wild fruit-bearing trees and shrubs, by means of which almost complete protection to cultivated fruit can be assured.

The chief essential is that the decoy trees shall be early bearing species, for it is the universal testimony that almost all of the damage done is to early fruit. How this applies in California is made clear in the following account of Professor Beal's experience in Alameda County. In the numerous orchards in Cull's Canyon only one grosbeak was seen where a week before, the last few days in May, they were common. It was a fine illustration of what has been demonstrated before—that the first fruits are the ones most eagerly eaten by the birds. When the early cherries were ripening in the orchard birds were to be seen on all sides—grosbeaks, orioles, tanagers, linnets, and jays, with now and then a blackbird or a flicker; but in June only one grosbeak and a few jays were seen, though the later cherries were just in perfection and nobody was disturbing the birds. A natural question is: Why are the later fruits comparatively immune to the attacks of birds? It may be urged that the feathered robbers get enough, that their appetites flag. While perhaps true of some birds, satiety in no way explains the facts concerning the black-headed grosbeak, since this bird consumes twice as much fruit in July and August as in May, though the quantity secured from cultivated sources is much less. It is evident that wild fruits are preferred, and that it is their abundance that protects the later ripening orchard varieties. In order to protect early cultivated fruit, therefore, it is necessary to plant decoy fruit trees which will come into bearing at the same time as the earliest varieties.

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[a] Troop, James, Bull. 53, Dec., 1894, pp. 125–126.

Such a fruit is the mulberry, which has long been known as a favorite of all frugivorous birds. There are many varieties derived from both foreign and native species, some one or other of which is suitable for any part of the United States. Perhaps the best of these to protect early fruit is the Townsend, which originated in northern Florida from the native red mulberry. This mulberry is very prolific and ripens fruit very early (in the latter part of March and April in Florida), a characteristic it will doubtless retain wherever it may be planted. Among other races of the same native stock are the Hicks, bearing in June and July, and the Stubbs, from June to August. The white mulberry of Asia (*Morus alba*) has yielded the Black English, the season of which is May to July, and the New American, fruiting at the same time, but very hardy, being adapted to mountain climates. The Russian mulberry (*Morus a. tatarica*) also is hardy, and bears in May and June. The suitability of the mulberry for California is affirmed by Prof. E. J. Wickson,[a] who says: "Nearly all varieties of the mulberry have been introduced in California and grown rapidly and thriftily." He commends the New American and Russian, mentioned above, and further states: "The mulberry has a long season. The Persian ripens in Tulare the last of May and continually thereafter until October."

Although the mulberry is an excellent fruit when fresh, it has been put to little use, the main reason no doubt being that it is not adapted to transportation. Since it is not of commercial importance, why not use it to protect more valuable fruits? The returns from such an investment, according to the testimony of many observers, are great. Dr. C. Hart Merriam says:[b]

> Groves of mulberry trees during the period of fruiting are thronged by hundreds if not thousands of birds, comprising many species and representing diverse groups. Such insectivorous kinds as flycatchers, warblers, vireos, and even cuckoos, form a part of the heterogeneous assemblage, departing from their customary diet long enough to join the multitude of blackbirds, orioles, finches, sparrows, tanagers, waxwings, catbirds, bluebirds, and thrushes, which from daylight until dark gorge themselves upon the tender berries. It seems incredible that such small birds as warblers, vireos, and the least flycatcher can open their tiny mouths wide enough to swallow such large berries as they really do gulp down with little effort. I know of no better tree than the mulberry to plant in public and private grounds for the purpose of attracting our resident birds.

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[a] California Fruits and How to Grow Them, San Francisco, 3rd ed., 1900, p. 398.

[b] Rept. Chief Div. Ornith. and Mamm. (1890), 1891, p. 285.

Further evidence of the attractive qualities of the mulberry is given by Dr. A. K. Fisher, who states that at his home in southern New York, a dark fruited, juicy Russian mulberry was a favorite food of a number of birds. Robins, catbirds, cedar birds, orioles, and to a less extent several other fruit-eating birds, fed by preference on mulberries, and rarely attacked cultivated cherries, which were abundant. In fact, as the period of mulberry ripening extended beyond the time of cherry harvesting, the more valuable fruit was almost completely protected from the depredations of birds.

The efficacy of the mulberry as a protection to cultivated fruits is fully confirmed also in a bulletin of the North Carolina Agricultural Experiment Station, which is exclusively devoted to the subject of mulberries:[a]

> They serve an excellent purpose near cherry trees and on strawberry plantations in attracting birds away from these fruits. As long as there are ripe mulberries close at hand, the other fruit will suffer very little from birds.

Such being the case, the several varieties of mulberries, on account of their great fruitfulness and the long bearing season, are well adapted to the protection of a wide range of fruit crops, including many of the later as well as the earlier ripening fruits.

Among other species valuable for the same purpose are certain inedible cherries. Mr. H. W. Henshaw informs the writer that a single tree of small sour cherries afforded almost complete protection to several trees of very fine cultivated cherries on the place of Mr. Joseph Palmer, near Washington. At the time a visit was made to this place, catbirds, robins, and orioles were abundant, and surprise was expressed that the crop of cherries was not molested. Pointing out a volunteer cherry tree, Mr. Palmer said: "There you see the reason; the birds will not touch the large cultivated cherries when the small ones are to be had."

Examination of this tree was made during the present year (1907). It proves to be the Mahaleb or Saint Lucie cherry (*Prunus mahaleb*). The 1907 crop of all kinds of cherries was very small, but as far as could be determined under the circumstances, the Mahalebs were preferred. In five minutes the writer noted in this tree 2 brown thrashers, 1 jay, 1 bluebird, 1 cedar bird, 1 kingbird, and 3 catbirds. All ate the fruit greedily. It appears that the birds must have cherries, though not the best varieties necessarily. Hence some such species as the Mahaleb is likely to afford more efficient protection than any other kind of fruit. It ripens with the cultivated cherries in this latitude and is very prolific, and since it is extensively imported for grafting stock it should be obtainable at low rates. The European bird cherry (*Prunus padus*), a most beautiful ornamental plant, also maturing fruit early, may be used to supplement the Mahaleb.

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[a] H. Hume and F. C. Reimer, No. 194, 1906, p. 56.

Other available trees and shrubs are juneberries, which fruit early, elderberries and blackberries for the summer, and a host, including native wild cherries, black and red haws, sumacs, and wild grapes, for the fall.

It may be objected by the orchardist that equal protection can be secured and, in addition, a saving of space be effected by simply increasing the number of fruit trees to allow for the loss by birds. It is doubtful, however, if this method would yield equivalent protection, since the injury would be widely distributed and some fruit spoiled on every tree; whereas decoy trees bearing the natural wild food of the birds will prove centers of attraction, and if they do not furnish enough fruit to satisfy the birds, the damage to the crop will be confined to a small number of trees in their immediate vicinity.

In this connection, in order to determine which are the best fruits to plant to draw the attention of the black-headed grosbeak, it is logical to consult the bird's own taste. We find elderberries far and away in the lead, they are eaten by a ninth of the whole number of birds examined and often compose from 70 to 100 percent of the stomach contents. Next in importance are blackberries, which have been discussed, and following these, juneberries (Pl. II, fig. 3), mulberries, and sumac fruits take equal rank. The bird is known to be fond also of the northwest black haw (*Cratægus douglasi*). It appears from the above facts that elderberries, juneberries, and mulberries are the most serviceable for diverting the attacks of the black-headed grosbeak from cultivated fruits.

In concluding this part of the subject it should be noted that although fruit is such a favorite food with the grosbeak, it constitutes only a limited part of the bird's diet, and that more than three times its bulk in injurious insects is eaten. Furthermore, the equivalent of three-fourths the amount of fruit is composed of other classes of vegetable matter, including weeds and grain.

GRAIN.

As has been stated above, wheat averages 2.08 percent of the stomach contents of the birds examined, and oats 1.83 percent. They were consumed by 8 and 10 grosbeaks, respectively. The bird rarely has been accused of injuring either grain, but we have a bit of testimony regarding its fondness for oats. Mr. S. H. Goodwin,[a] referring to newly sown fields in Utah, states:

> I have seen these birds in oat fields again and again, and have found them fairly stuffed with oats. But at most the damage is slight, for the birds are not sufficiently numerous to make them a serious factor in this direction, and the services rendered are many.

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[a] Deseret Farmer, III, 1907, No. 27, p. 8.

Oats may be injured later in the season when in the milk, as some were found in the stomach of a nestling blackhead. This grain, however, may have come from the abundant wild oats. In any case, the small percentage of grain consumed precludes serious injury under all but the most exceptional conditions.

WEED SEED AND OTHER VEGETABLE FOOD.

From April to August, inclusive, weed seeds constitute an average of 8.74 percent of the food of the blackheaded grosbeak. Most of the seeds are derived from noxious plants; hence their destruction is a service. Alfilaria (*Erodium*) seeds were taken by 13 birds, and chickweed (*Alsine*) by the same number. The little shining black seeds of red maids (*Calandrinia*) were eaten by 8 individuals, and the large fleshy akenes of the milk thistle (*Mariana*, Pl. II, fig. 12) by 5. Professor Beal several times has observed blackheads feeding on the latter seeds, and the birds are known to be quite fond also of the similar seeds of the garden sunflower. Among other weed seeds found in the stomachs are tumbleweed (*Amaranthus*, fig. 18), smartweed (*Polygonum*, fig. 1), dock (*Rumex*), nightshade (*Solanum*), catchfly (*Silene*), geranium, and bur clover (*Medicago*).

A few miscellaneous things, such as spires and wads of grass, coniferous leaves, and galls, were present in a few stomachs.

Several items not detected in the stomachs examined are mentioned by other writers, and among them are garden peas, which it will be remembered are relished by the rosebreast also. Dr. J. A. Allen[a] wrote in 1872 that in Utah the blackhead is "called 'pea bird,' it being very fond of young peas, and is hence regarded as obnoxious."

Mr. Jackson Tabor, of Folsom, N. Mex., in connection with hi description of the bird's depredations on fruit says:

> They commenced on early vegetables, took the pea crop in toto, and put in their work on everything in the garden, even eating green beans that I never knew anything else to touch. (September 2, 1903.)

The bird shares in a taste said by many to be characteristic of all grosbeaks, and Mr. Henshaw[b] in 1876, writing of the bird's habits in the middle region of the West, states that—

> It appears especially fond of the buds of various deciduous trees and plants, and the bills of many of those taken had been stained and gummed with their juices.

At times it feeds extensively on willow buds, according to Doctor Coues, and Mr. Ridgway says that in May, in Truckee Valley, Nevada, it was observed to feed on the buds of the greasewood.[c]

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[a] Bull. M. C. Z., III, 6, 1872, p. 168.

[b] Zool. Expl. West of 100th Meridian, V, 1876, p. 297.

[c] Geol. Expl. 40th Parallel, IV, Pt. III, 1877, p. 488.

ANIMAL FOOD.

Insects and other animal matter eaten by the black-headed grosbeak amount to almost twice the bulk of the vegetable food, or 65.85 percent of the total subsistence. These, then, should be regarded as the really staple foods of the species. While no single vegetable element was fed upon by more than 41 grosbeaks, certain items of the insect diet were chosen by more than a hundred, or over half of the birds examined. This fact suggests that if the majority of the insects preyed upon are noxious, the benefits conferred by the bird greatly outweighs the injury inflicted.

Coming, then, to the economic status of the insects devoured, it appears from the results of the examination of 226 stomachs that 3.37 percent of the bird's food consists of ground beetles, fireflies, and ladybirds, which usually are considered beneficial; 2.56 percent is composed of wasps, ants, bees, etc., some of which are very useful, some innocuous or harmful; and 1.17 percent is made up of a great number of unrelated items, largely of neutral import, which, owing to the fact that they are rarely eaten, have little significance. Thus 58.75 percent, or nearly three-fifths of the entire food, is composed almost wholly of insects which are a constant menace to agriculture.

Of the above classes the beneficial kinds deserve first consideration. The most important among them numerically are fireflies (Lampyridæ), which are almost uniformly carnivorous, both as larvæ and as adults. Since they do much to check the increase of many other insects, the destruction of large numbers would be injurious. Fifty-two of the grosbeaks examined had fed upon fireflies to the extent of 2.38 percent of the whole food. Both adults and larvæ were captured, from 5 to 19 of the former and from 12 to 30 of the latter being found in some stomachs.

Among other useful insects which are attacked by the blackhead are the ground beetles (Carabidæ). Nineteen grosbeaks ate them, and they amount to 0.99 percent of the food. Since so few of these beetles are captured and as certain of them at times feed upon plants, the injury is too slight to be noticed.

Three black-headed grosbeaks ate small ladybird beetles which prey upon scale insects and plant lice, two of them securing specimens of an Australian coccinellid (*Rhizobius ventralis*, fig. 33), which was introduced into California for the express purpose of destroying scale insects. If the grosbeak destroyed many of these beetles, the bird would have to be given a black mark, but when it is considered that the blackhead feeds upon scale insects a large part of the time (more than a fifth of its food consisting of scales), it is surprising that so few of the ladybirds are devoured.

Considerable liking, however, was shown for another group, the Hymenoptera, part of which at least are beneficial. The most useful members of this order are the parasitic Hymenoptera, which lay their eggs in the eggs or young of other insects. Remains of insects of this class from the stomach of one grosbeak were identified and they amounted to 22 percent of its contents. Two bees were found in another stomach, one of which was a worker honeybee. These are the only beneficial species of Hymenoptera from stomachs of this grosbeak positively identified, but it is probable that many of the unidentified forms belong in the same category. In all, 58 grosbeaks fed upon wasps, bees, and ants, very many of which selected large wasps, which were most probably workers of some social species the loss of which would not be noticed. Eleven blackheads ate ants, including both pupæ and adults, for which the birds are to be commended, as many ants are prejudicial to the interests of man.

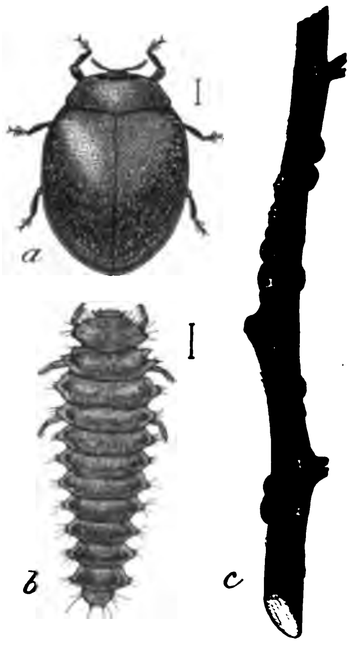

Fig. 33. — An Australian ladybird (*Rhizobius ventralis*). (From Marlatt, Bureau of Entomology.)

Summing up the relations of the black-headed grosbeak to beneficial insects, Hymenoptera constitute 2.56 percent of the food, not all of which, as just noted, is to be set down against the bird. The wholly useful fireflies amount to 2.38 percent, the mainly beneficial ground beetles to about 1 percent, while the ladybirds are a mere trace. Thus only about 5 percent, or a little more, of the bird's food consists of insects the destruction of which is prejudicial to the welfare of man. Even were the bird not useful otherwise, this showing would hardly justify reprisals.

As a matter of fact, however, the blackhead is far from useless, since the remainder of the animal food, which is fully 11 times the bulk of the useful insects, consists of pests upon some of which no other bird is known to prey so extensively. Beetles of various families constitute about half the bulk of these harmful insects, and 28.71 percent of the total food. A much greater number of grosbeaks preyed upon leaf beetles (Chrysomelidæ) than any other family, these composing 17.98 per cent of the diet. One hundred and seventy-two blackheads, or almost four-fifths of the total number examined, captured leaf beetles, which are said to include among their ranks more enemies of crops, shade trees, and ornamental plants than any other family of beetles.

While this unmistakable preference for the often pungently flavored Chrysomelidæ is remarkable, it is still more surprising that of the 172 birds 103 selected a single species, the California flower-beetle (*Diabrotica soror*, almost indistinguishable from *D. 12-punctata*, fig. 26). This insect, according to Prof. Vernon L. Kellogg,[a] "does great damage as an adult by eating into the flower buds of roses, chrysanthemums, and a host of others, the larvæ feeding on the roots of alfalfa, chrysanthemums, and many other plants." Prof. E. J. Wickson adds,[b] it "is sometimes very injurious to early fruit by eating into it when ripe. The insect also eats leaves and blossoms. As the insect attacks the fruit just as it is ready to pick, it is impossible to apply any disagreeable or poisonous spray."

In connection with the latter testimony it is of interest to recall that the early fruits are the ones that the bird also injures most severely. Although less than 4 percent of the food, strictly speaking, can be called early fruit, and the total amount of cultivated fruit eaten during the bird's stay in California is only about 12 percent, the fruit-destroying flower-beetle, which it is impossible for man to combat effectually, constitutes more than 14 percent. In view of this fact alone, it would seem that the hand raised with deadly intent against the grosbeak when pilfering fruit may well be stayed. The beetles, though not so easy to see as the grosbeak, are present in countless hordes and busy at their destructive work. But the grosbeak finds and consumes more of them by actual bulk than of cultivated fruit. Furthermore, in view of the fact that 103 out of 226 black-headed grosbeaks preyed upon the flower-beetle, often securing from 8 to 21 each, and that 14.08 percent of the bird's entire food consists of these insects, it can be unhesitatingly stated that the black-head is one of the most important checks upon this pest.

While the grosbeak does not destroy any other insect to anything like the same extent that it does the flower-beetle, nevertheless it shows a considerable liking for some other leaf-beetles. Seventeen grosbeaks fed upon a species (*Melasoma scripta*) that is fond of the foliage of willows and poplars, and 15 devoured a dock-inhabiting leaf-beetle (*Gastroidea*), which sometimes eats pine needles; from 9 to 33 of these were found in a single stomach. About 37 grosbeaks ate leaf-beetles which could not be specifically identified.

The closely related family of long-horned wood-borers (Cerambycidæ) furnishes 2.29 percent of the bird's fare, and since the longicorns contain among their ranks numerous disastrous pests, the bird must be commended even for the moderate liking for them it displays. Click-beetles (Elateridæ), which in the larval state are known as wireworms, were devoured by 30 black-headed grosbeaks, but constitute only 0.77 percent of the food. Weevils also are sparingly consumed, which is in contrast to the avidity shown for them by most insect-eating birds. Twenty-five of the present collection of blackheads obtained specimens of these queer snouted beetles, but they compose less than 1 percent of the subsistence.

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[a] American Insects, 1905, p. 280.

[b] California Fruits and How to Grow Them, 1900, pp. 454–455.

Bronzy wood-borers (Buprestidæ) were captured by 8 grosbeaks, pine-feeding species being identified. Lamellicorn beetles (Scarabæidæ) fell a prey to 10 birds, but no important species were secured. A few blackheads obtained representatives of other coleopterous famlies, such as rove-beetles (Staphylinidæ), darkling beetles (Tenebrionidæ), and whirligig beetles (Gyrinidæ), one of which was found in a single stomach, though how the bird secured this aquatic species is a mystery. A quick tiger-beetle (*Cicindela*) also was found in a single stomach, and hence, although beneficial, it may be passed by without comment.

Coleopterous larvæ were eaten by 7 birds, 2 of which had secured representatives of the family Nitidulidæ. As these larvæ are too minute to have been eaten intentionally, and since they feed on decaying fruit, their presence among the stomach contents shows that the grosbeak also sometimes eats decayed fruit. Some of the fruit pulp, therefore, which could not be identified, but which was provisionally reckoned against the bird, is thus proven to have no value.

Grasshoppers, which are eaten by birds almost universally, are neglected by this species, as they are also by the rose-breasted grosbeak. Only 7 of the 226 blackheads examined had eaten them, and they constitute only 0.25 percent of the subsistence. Nevertheless, the black-headed grosbeak is included among the enemies of the Rocky Mountain locust by Samuel Aughey, who examined 2 specimens, one of which had eaten 8, the other 17 locusts.

Notwithstanding the blackhead is rather whimsical about a grasshopper ration, it shares the taste of most other birds for caterpillars, and it devours them and their chrysalids to the extent of 9 percent of its food. Spines and hairs, popularly supposed to be abhorred by birds, do not deter the blackhead, and sometimes all that is left in the stomach to tell of the capture of caterpillars is a mass of thorns and spines. Exactly 100 black-headed grosbeaks fed upon lepidopterous insects, 70 of them choosing caterpillars and 30 cocoons and chrysalids. It is among remains of the latter that we find representatives of the most important species in the order—the codling moth (fig 34). This pest is said to cause a loss of not less than $10,000,000 annually to the fruit growers of the United States. Inasmuch as the insect has no important parasites, its feathered enemies should be all the more appreciated, and it is safe to say that, with the probable exception of woodpeckers, the blackhead is the equal of any of them.

The codling moth is accessible to the grosbeak in two stages of its development, namely, when the larvæ are seeking a place to hibernate or pupate, as the case may be, and when they are in the chrysalis stage. By no means all of the birds examined had access to the species, yet 25 were successful in finding the pupæ or larvæ, and secured from 1 to 29 individuals, averaging about 5 each. It appears, therefore, that the grosbeak makes good use of its limited opportunities, and we agree with Professor Beal[a] that the "bird that helps to destroy this * * * insect, the curse of * * * apple culture, will be hailed as a blessing in spite of any shortcomings it may have."

Second in importance only to the above pest are cankerworms.

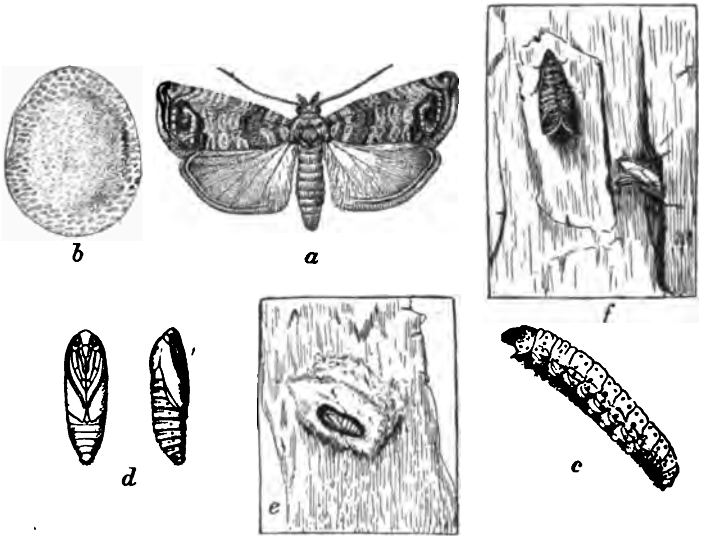

Fig. 34. Codling moth (*Carpocapsa pomonella*). (From Simpson, Bureau of Entomology.)

The spring cankerworm (*Paleacrita vernata*, fig. 35), which is responsible for a great deal of damage in apple orchards, constitutes 6 percent of the grosbeak's food in May. While this amount is not large, it is nevertheless worthy of note, since all of it is consumed when the earliest broods are developing.

Only one other order of insects contributes largely to the subsistence of the black-headed grosbeak—the true bugs, Heteroptera-Homoptera. Among minor items of the order the Heteroptera collectively form 1.05 percent of the diet, plant bugs, together with members of the squash-bug and stink-bug families and unidentified forms, being eaten by 18 birds. A miscellaneous assemblage from the other group (Homoptera), including leaf and tree hoppers, plant lice, and cicadas, was distributed among 9 of the grosbeaks examined, and composes a little more than 0.5 percent of the total food. Next is the family of scale insects (Coccidæ), which from an economic standpoint is the most important element of the black-headed grosbeak's food. Scale insects were fed upon by all but 81 of the 226 birds examined.

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[a] Yearbook Dept. Agr., 1904, p. 248.

The destructiveness of these insects need not be explained to anyone in the western fruit-growing region, where the disastrous effects of their presence have been keenly felt for many years, longer in fact than in any other part of the country. Suffice it to say that scale insects cause more trouble and loss to fruit growers than all other pests combined, and the damage from them is to be reckoned by millions of dollars.

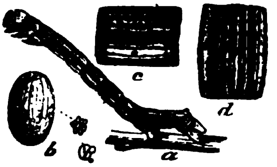


FIG. 35.—Spring cankerworm (*Paleacrita vernata*). (From Riley, Bureau of Entomology.)

The black-headed grosbeak evinces a distinct preference for the most widely distributed and abundant scale insect on the coast—the black olive scale (*Saissetia oleæ*, fig. 36) the importance of which the following notes from the writings of Prof. E. J. Wickson, of the University of California, will serve to show. It affects both citrus and deciduous trees, but is especially troublesome to the olive, and it will spread quickly to ornamental plants and vines. It is a very difficult scale to subdue, and in spite of the fact that immense numbers are killed by parasites it is still a grievous pest. This insect constitutes 20.32 per cent of the grosbeak's entire food, being eaten by 123 birds, many of which had secured from 12 to 32 scales each. If this service alone is not sufficient to atone for all the bird's depredations on fruit, the latter must be held at an exceedingly high price.

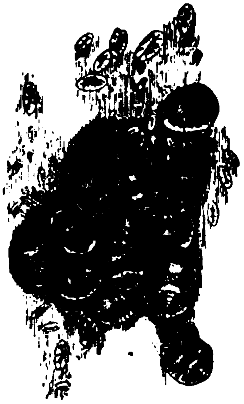


FIG. 36. — Black olive scale (*Saissetia oleæ*). (From Marlatt, Bureau of Entomology.)

Moreover, all has not yet been said in the bird's favor. It does not confine itself to the black olive scale alone, but at times probably preys extensively on other species. Sixteen other grosbeaks consumed enough scales to make up 2.26 per cent of the total food. Among the scales they ate are the brown apricot scale (*Eulecanium armeniacum*) and the frosted scale (*E. pruinosum*), both of considerable economic importance.

The remaining constituents of the animal food have slight percentage value. Fifteen grosbeaks devoured spiders or their cocoons, these items amounting to 0.34 percent of the entire regimen. Among other substances of little importance are snails, eaten by 14 birds, various unidentified insect pupæ by 10, eggshells by 5, and flies by 2; and, most remarkable for a bird of the blackhead's feeding habits, a bit of bone and the remains of a small fish were found in a single stomach each.

MINERAL MATTER.

The average percentage of mineral matter in the stomachs of the whole number of birds examined is 2.35. The nestlings of 2 or 3 days' age had none; those of a week, 6.57 percent; and those of 2 weeks, only 3 in number, however, had 2.33 percent.

NESTLINGS.

We are fortunate in having a fair amount of material to illustrate the food habits of the nestling black-headed grosbeaks. The nestlings at hand are readily divisible into three groups, separated both by age and character of the diet. Ten, comprising two broods of 3 each and one of 4, which were collected at the age of 2 and 3 days, had been fed animal matter exclusively. Seven, made up of two broods, numbering 3 and 4 individuals, respectively, had reached the age of 7 and 8 days, at which period a small amount, namely, 2.1 percent, of vegetable food had been introduced into the dietary, while 3 scattered fledgelings of a fortnight's growth consumed an average of 13.3 percent of vegetable substances, mainly fruit.

Two-thirds of the food of the youngest or entirely insectivorous group consisted of caterpillars, much over half of which, to wit, 37.2 percent, was spring cankerworms (*Paleacrita vernata*, fig. 35). In addition, 18 percent was composed of pupæ of the codling moth (fig. 34), which, indeed, were fed to part or all of each brood, including 8 of the 10 nestlings. If the habit of feeding these important pests, on the scale here indicated, to nestlings, whose never-ceasing demands for food are proverbial, is general, the amount of destruction wrought in their ranks is almost incalculable. Besides the codling moth and cankerworm, the flower-beetle and black olive scale also figure in the diet of this lot of youngsters; and longicorn beetles, spiders, leafhoppers, other bugs, and ant pupæ likewise were consumed.

One brood of the second group, which was just being initiated into the use of vegetable food, was given oats in the milk, while the other family was entirely carnivorous. More hard-bodied insects are fed at this age, beetles composing three-fourths of the whole diet, and over 28 percent was contributed by the flower-beetle alone. Black olive scales are most important among the remaining elements, 12 percent being composed of these pests. Hymenoptera, caterpillars, spiders, and insect eggs also were taken, and each of the members of one brood had a few bits of eggshell in its stomach.

Caterpillars again enter into the diet of the two-weeks old fledgelings, composing 45 percent of the whole amount, 21 percent being cankerworms. Black olive scales are 7 percent, and beetles, including lamellicorns, ground and click beetles, compose 26 percent of the food, the remaining animal elements being Hymenoptera and snails. The vegetable matter, 13.3 percent of the whole food, consists of cherries, strawberries, blackberries, bits of wheat, a few seeds, and spires and wads of grass, which last-named articles curiously enough are found in the stomachs of many other nestling birds.

The oldest fledgelings thus approximate more nearly in diet to that of the adults, even partaking of their fruit-eating habits. It is evident also, from the study of nestling blackheads, that vegetable matter is fed in gradually increasing quantities, corresponding, probably, either as cause or effect, to the growing muscular development of the stomach. Some grosbeaks observed by Professor Beal fed their nestlings only two to five times per hour, but as the feeding was accomplished by regurgitation it is probable that the stomachs of the young were practically filled during every visit to the nest.

Reviewing, it has been noted above that the nestlings of the black-headed grosbeak are fed a great number of codling moth pupæ, cankerworms, flower-beetles, and black olive scales, the destruction of which is greatly to the advantage of agriculture. When very young their food is entirely animal, and consists in great part of these grievous insect pests.

SUMMARY.

Examination of 226 stomachs of the black-headed grosbeak, the majority of which were collected in California, shows that during six months' stay in its summer home the bird consumes on the average 34.15 percent of vegetable and 65.85 percent of animal food.

Reports that the bird damages cultivated fruit are fully sustained by stomach examinations, figs and cherries appearing to be the kinds most injured. From 10 to 15 per cent of the food consists of cultivated fruits; a slightly smaller amount is weed seed, while the proportion of grain devoured is trifling.

It has been brought out that small orchards may be economically protected by means of bird netting. Large orchards may be protected in great measure by planting here and there suitable decoy trees, as mulberries.

Aside from the fact that ravages by the grosbeak may be prevented or greatly reduced without destroying the birds, it is evident that their general services to agriculture are so valuable that their destruction is not to be considered. It is to be noted: First, that the animal food of the blackhead, consisting almost wholly of injurious insects, is practically twice the bulk of the vegetable food, or more than four times that portion which is pilfered from man. Second, that the bird could not possibly select insects more prejudicial to the interests of western horticulture than the ones forming its natural food. These include the codling moth, cankerworms, flower-beetles, and such scale insects as the frosted, apricot, and black olive scales. Finally, these formidable fruit destroyers alone, not to mention 20 percent of other injurious insects, compose two-fifths of the entire amount of the black-headed grosbeak's food from April to September, or at least three times as much by actual bulk as the fruit consumed. In other words, for every quart of fruit eaten, more than 3 pints of black olive scales and more than a quart of flower-beetles, besides a generous sprinkling of codling moth pupæ and cankerworms fall prey to this grosbeak.

LIST OF SEEDS, FRUITS, AND INVERTEBRATES EATEN BY THE BLACK-HEADED GROSBEAK.

GRAIN.

Oats (*Avena sativa*).
Wheat (*Triticum vulgare*).

CULTIVATED FRUITS.

Fig (*Ficus carica*).
Mulberry (*Morus* sp.).
Strawberry (*Fragaria vesca*).
Blackberry (*Rubus* sp.).
Crabapple (*Malus prunifolia*).
Apricot (*Prunus armeniaca*).
Cherry (*Prunus cerasus*).
Prune (*Prunus domestica*).

WILD FRUITS.

Juneberry (*Amelanchier* sp.).
Poison oak (*Rhus diversiloba*).
Nightshade (*Solanum nigrum*).
Elderberry (*Sambucus* sp.).

WEEDS.

Dock (*Rumex* sp.).
Smartweed (*Polygonum* sp.).
Pigweed (*Amaranthus* sp.).
Red maids (*Calandrinia menziesi*).
Catchfly (*Silene* sp.).
Chickweed (*Alsine media*).
Cranesbill (*Geranium* sp.).
Alfilaria (*Erodium* sp.).
Bur clover (*Medicago denticulatum*).
Milk thistle (*Mariana mariniana*).

COLEOPTERA.

- Tiger beetles (Cicindelidæ):
  - *Cicindela* sp.
- Ground beetles (Carabidæ):
  - *Platynus variolatus.*
- Whirligig beetles (Gyrinidæ).
- Rove beetles (Staphylinidæ).
- Ladybird beetles (Coccinellidæ):
  - *Psyllobora tædata.*
  - *Rhizobius ventralis.*
- Nitidulidæ.
- Click-beetles (Elateridæ):
  - *Megapenthes elegans.*
- Bronzy wood-borers (Buprestidæ):
  - *Buprestis lineata.*
  - *Buprestis fasciata langi.*
  - *Acmæodera gibbula.*
- Fireflies (Lampyridæ):
  - *Podabrus* sp.
  - *Telephorus consors.*
  - *Telephorus divisus.*
- Lamellicorn beetles (Scarabæidæ):
  - *Aphodius inquinatus.*
  - *Euphoria* sp.
- Long-horned beetles (Cerambycidæ):
  - *Leptura militaris.*
- Leaf beetles (Chrysomelidæ):
  - *Syneta albida.*
  - *Gastroidea cyanea.*
  - *Melasoma scripta.*
  - *Diabrotica soror.*
  - *Diabrotica trivittata.*
- Darkling beetles (Tenebrionidæ).
- Rhynchitidæ:
  - *Deporaus glastinus.*
- Scarred snout-beetles (Otiorhynchidae):
  - *Scythropus californicus.*
- True snout-beetles (Curculionidæ):
  - *Dorytomus hispidus.*
  - *Baris* sp.
  - *Balaninus* sp.

HEMIPTERA.

- Cicadas (Cicadidæ):
  - *Cicada* sp.
- Tree-hoppers (Membracidæ).
- Scale insects (Coccidæ):
  - *Saissetia oleæ.*
  - *Eulecanium armeniacum.*
  - *Eulecanium pruinosum.*
- Leaf-hoppers (Jassidæ).
- Jumping plant-lice (Psyllidæ).
- Plant-lice (Aphididæ).
- Stink-bugs (Pentatomidæ).
- Coreidæ.
- Plant-bugs (Capsidæ).

ORTHOPTERA.

- Short-horned grasshoppers (Acridiidæ).

LEPIDOPTERA.

- Spanworms (Geometridæ):
  - *Paleacrita vernata.*
- Leaf-rollers (Tortricidæ):
  - *Carpocapsa pomonella.*

HYMENOPTERA.

- Apidæ (*Apis mellifera*).
- Rough-headed ants (Myrmicidæ).

DIPTERA.

- Borboridæ (*Borborus* sp.).

OTHER INVERTEBRATES.

- Spiders (Araneida).
- Snails (Gastropoda).

BLUE GROSBEAK.

(*Guiraca cærulea*, Plate IV.)

APPEARANCE, DISTRIBUTION, AND HABITS.

While less strikingly colored than other grosbeaks, this species equals them in beauty. The general color of the male is ultramarine, but the tail and wings are black, with bars of chestnut crossing the latter. The female is much duller. Brownish above and below, with a lighter throat, she bears a marked superficial resemblance to the female cowbird, and the massive bill is the only conspicuous feature that serves to distinguish the two.

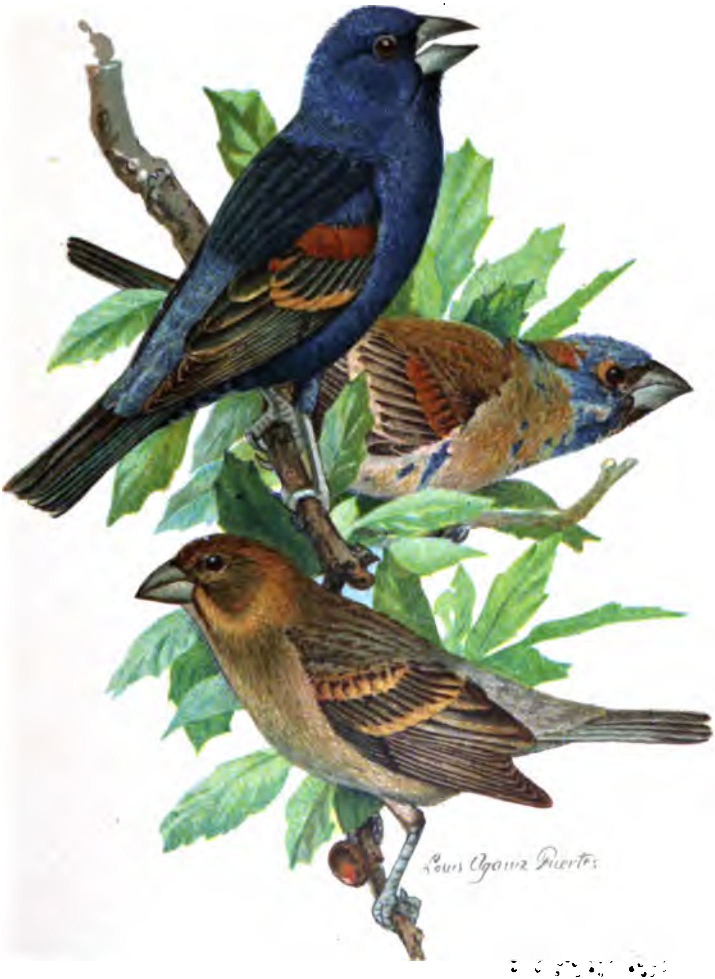
This is the smallest of the grosbeaks, and occupies a wider range in the United States than any of the others. There are two subspecies of blue grosbeaks, the western one breeding from southernmost Mexico to northern California and southern South Dakota and the eastern from the gulf coast to southern Pennsylvania and southeastern Nebraska. The two races merge in eastern Texas, Oklahoma, and Kansas. In winter both withdraw entirely from the United States.

During the breeding season the blue grosbeak is locally abundant in the southern and western parts of its range, being in some places a familiar garden and orchard bird. In the eastern part of the Mississippi Valley, however, and in the Atlantic States, it is shy, retiring, and generally rare.

In the latter regions the nest is usually placed in a low bush or vine in a thicket; but where the birds are more common they build in fruit trees or even in cultivated ornamental plants about houses. Everywhere the species nests late. The eggs are 3 or 4 in number and are bluish white; two broods are raised in the south and one in the north. In common with all its relatives, this handsome bird is a good singer, and its song, though weak, suggests the rosebreast's lovely carol. Its pleasing song and engaging appearance have made the grosbeak a favorite cage-bird among the southern creoles, who know it as the "blue pop."

ECONOMIC RELATIONS.

The present investigation of the food habits of this species concerns only summer residents of the United States. Fifty-one stomachs have been examined, which were collected in every month from April to September, inclusive, and in seven States and the District of Columbia. Of the food they contained 67.6 percent is animal matter and 32.4 percent vegetable. No month is represented by more than 19 birds; hence the results obtained are by no means as reliable as could be desired. However, as the economic relations of the blue grosbeak are almost entirely unknown, even these tentative findings have a distinct value.



BLUE GROSBEAKS.

[Top figure, adult male; middle figure, immature male; bottom figure, female.]

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VEGETABLE FOOD.

The proper valuation of the vegetable elements of a bird's food is of great importance, since upon this point largely depends the attitude of the agriculturist toward the bird. The main question is, Does the blue grosbeak appropriate an undue amount of the product of field, orchard, and garden crops?

Vegetable substances consumed by the blue grosbeak and constituting 32.4 percent of its food may be classified as follows: Grain, 14.25 percent; weed seed, 18.05 percent; fruit, 0.06 percent; and miscellaneous, 0.04 percent.

FRUIT.

From present information it appears that cultivated fruits are not molested by the blue grosbeak. All writers agree that the little fruit eaten is wild, a conclusion supported by the results of the present examination. Only two birds, both young, had eaten fruit of any kind, and in each case it consisted of a few bits of blackberry, undoubtedly wild.

GRAIN.

Grain constitutes 14.25 percent of the food of the birds examined. Wheat was eaten by 6 of the total number, and amounts to 8.33 percent of the entire subsistence. Corn was eaten by 4 birds and is 4.87 percent of the food, while oats, which form 1.05 percent, were consumed by only 2 of the 51 birds. Probably all this grain was obtained from cultivated crops.

One grosbeak, collected in a wheat field in June, had eaten enough of the milky cereal to make up 40 percent of its stomach contents. Three others from the same region in the same and the succeeding two months had devoured wheat, which shows that this grain is relished even in the riper stages.

Apparently the corn in the stomachs also came from the standing crop, and while the blue grosbeak seems too small to be an active depredator of such a well-protected grain, yet with its powerful beak there is no doubt that it can as readily shear through the enveloping husks as crack the kernels themselves. Referring to this latter point, Wilson says of a captive bird: "I fed it on Indian corn, which it seemed to prefer, easily breaking with its powerful bill the hardest grains." Notwithstanding this the bird does little damage. At all events, no complaints of injury have been made.

There is testimony, however, that the bird does some mischief in oat fields. Doctor Fisher, of the Biological Survey, has seen flocks feeding upon this cereal in Nebraska and in California, and the same habit has been observed in Virginia. In general this occurs late in summer. After the nesting season blue grosbeaks change their habits greatly. The once timorous birds leave off their shyness; the isolated families assemble, and flocks, usually small, but sometimes large, raid the grain fields. Oats and rice especially are injured by them. Concerning the effect of the blue grosbeak upon rice in Louisiana, Mr. George Beyer[a] says: "In the Florida parishes * * * it is generally called 'rice bird.' Flocks of thousands descend upon the ripe rice during August and September." As noted above, oats were found in 2 stomachs examined during the present investigation, rice in none.

Summary.—Only 11 of the 51 blue grosbeaks examined had eaten grain, from which it is evident that this food is not specially sought, even when accessible. Grain constitutes 14.25 per cent of the total food, but only one bird ate grain exclusively. Considering only the 11 cereal feeders, we find they were satisfied with a fare of half grain, and preferred to eat insects and other food along with it. It seems, therefore, that in summer this grosbeak does not evince a decided taste for grain, and, being widely and sparingly distributed, it is inconceivable that noticeable loss can be caused by it.

That the reverse is true later in the year is well established, but the injury then committed seems to be of no great importance, or it would have attracted more attention. It is certain that the blue grosbeak is not for an instant to be ranked with such well-known grain pests as the bobolink and some of the blackbirds, and the cases of serious injury attributable to it are clearly of rare occurrence and brief duration.

Moreover, during by far the greater part of the bird's stay in the United States its food habits are decidedly beneficial, and it consumes almost five times as great a bulk of injurious insects as of grain. Without doubt the farmer could afford to pay for the destruction of these insects with grain in the reverse ratio and yet make a large profit by the bird's services.

WEEDS.

Weed seeds are consumed by the blue grosbeak during every month of its stay in the United States. They constitute 18.05 per cent of the total food, and thus are given preference over all other items of the vegetable regimen. Not a great variety of seeds are devoured, and more of foxtail (fig. 37) and bindweed (fig. 21) are taken than any others. It is well known that these weeds are among the most troublesome in America, striving constantly to overtop and crowd out cutivated plants, while bindweed during its earlier stages harbors the corn root-louse, one of the most injurious of grain pests. Practically all birds to any degree vegetarian feed upon the seeds of these weeds, a work of which the blue grosbeak assumes a proper share and the value of which in the aggregate is immense.

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[a] Avifauna Louisiana, New Orleans, 1900, p. 34.

Before leaving the subject of vegetable food, it should be mentioned that one blue grosbeak, collected in the District of Columbia, had fed largely upon the seeds of wild rice (*Zizania aquatica*). This plant is an important source of food for many larger birds, especially ducks and geese, but is not generally sought by the smaller species.

ANIMAL FOOD.

The blue grosbeak consumes more than twice as much animal as vegetable food, and it consists of snails, spiders, and various insects. The latter constitute 65.7 out of 67.6 percent, the entire amount, and while comprising for the most part injurious species, include a few forms generally considered useful. These will be discussed at once.

A certain family of ground-inhabiting beetles, the Carabidæ, on account of their predaceous habits, are usually classed as beneficial. They have been detected, however, feeding upon vegetable matter, and in many places even upon cultivated crops. These facts should make us slow to condemn a bird for picking up a few of them. The present species manifests very little liking for ground-beetles, only 4 birds of the entire number having taken them, and in no case did they constitute more than 10 per cent of the stomach contents.

FIG. 37.—Seeds of green foxtail (*Chætochloa viridis*). (From Hillman, Nevada Experiment Station.)

One other predaceous insect was captured. This was a robber fly (Asilidæ). Flies of this family capture grasshoppers, beetles, other flies and bees, and at times do considerable mischief among honey bees. They are not wholly beneficial, therefore, although probably the balance is in their favor. If it is the rule, however, as appears from the present examination, that not more than 1 blue grosbeak in 50 takes a robber fly, the resulting damage need not disturb us.

Besides the insects of predatory habits, there are others which are useful as parasites. None of these were taken directly by any of the blue grosbeaks examined, but about 20 eggs of a parasite, probably a tachina fly, were attached to the body of a purslane caterpillar eaten by one of the birds. Had these parasitic flies been allowed to complete development they would have attacked and destroyed other caterpillars, but probably not so many as the grosbeak which fed upon them, one-tenth of whose food would have consisted of these creatures.

Caterpillars and adult lepidoptera (moths) compose 9.77 percent of the food of the blue grosbeak. The purslane caterpillar (fig. 38) mentioned above is eaten by adults and is fed also to the nestlings.

Ordinarily this insect is harmless, but occasionally it attacks garden and fruit crops, especially the sugar beet. Another caterpillar also, the cotton cutworm (*Prodenia ornithogalli*, fig. 9), which attacks the latter crop as well as the tomato and cotton, is devoured by the blue grosbeak. Four birds, taken in the cotton fields of Texas in May, had eaten 9 cotton cutworms, which constituted more than 40 percent of their food. Many other caterpillars also of the same family (Sphingidæ), as the purslane feeder, and two moths were consumed by the blue grosbeaks examined. Because of the injurious habits of these insects their destruction by the grosbeak is to be commended.

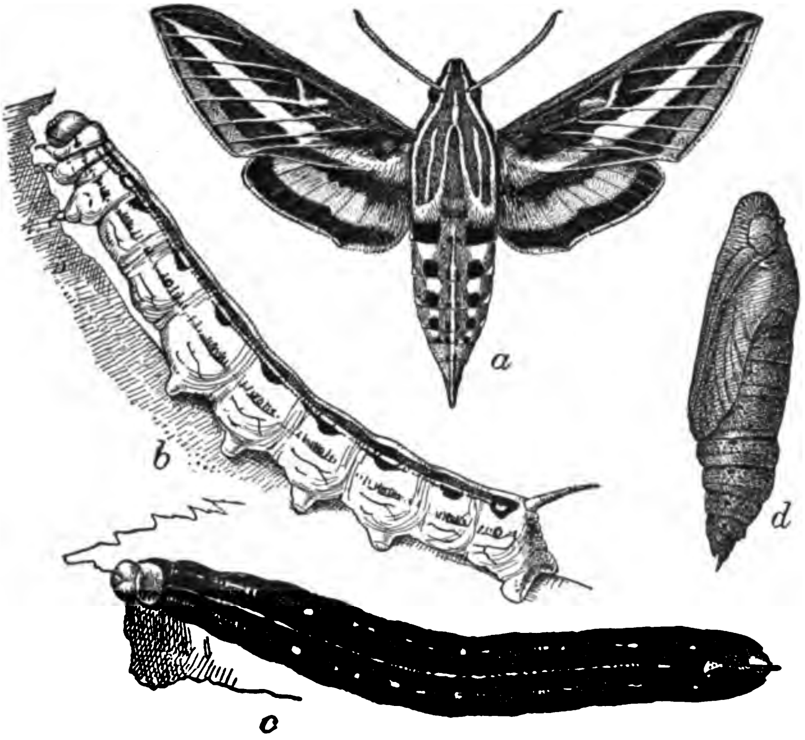

FIG. 38.—Purslane caterpillar (*Deilephila lineata*). (From Chittenden, Bureau of Entomology.)

The true bugs (Hemiptera) constitute another group of insects, mainly injurious, and all of them eaten by the grosbeak are destructive. These include members of the squash-bug family (Coreidæ), stink-bug family (Pentatomidæ), tree-hoppers (Membracidæ), and cicadas or harvest flies (Cicadidæ). One blue grosbeak from South Dakota had eaten 3 of the latter, which composed 94 percent of its stomach contents.

Injurious beetles comprise 24.4 percent of the grosbeak's food, almost half (11.25 percent) of which amount consists of members of the May beetle family (Scarabæidæ). Adult June bugs, and their larvæ, the white grubs, were devoured by some birds to the exclusion of other food, and 1 grosbeak had eaten 3 of the common dung-beetles (*Aphodius fimetarius*). Weevils are next in importance among beetles, and 7.18 percent of the bird's seasonal food was made up of these pests. Many of them were scarred snout-beetles (Otiorhynchidæ) and curculios (Curculionidæ); some of them certainly were injurious species. Two grosbeaks selected the conspicuously red and black colored billbug (*Rhodobœnus 13-punctatus*), each eating 2. Leaf-beetles (Chrysomelidæ), wood-borers (Buprestidæ), click-beetles (Elateridæ), and long-horned beetles (Cerambycidæ), nearly all of which are injurious, were also devoured.

The most important element of the animal food, however, is grasshoppers. Crickets and long and short horned grasshoppers are eagerly consumed, composing 27.2 percent of the total food. Thirty-two of the 51 blue grosbeaks ate them, several taking nothing else. They are fed to the nestlings in generous measure, and without doubt are the most important single article of diet. During one of the historic outbreaks of the Rocky Mountain locust, the blue grosbeak was found to feed on other grasshoppers among the swarming hordes, and it is certain that the pest itself was not overlooked. A very closely-related species, called in contradistinction the lesser migratory locust (*Melanoplus atlanis*, fig. 39), has been identified from the stomachs examined.

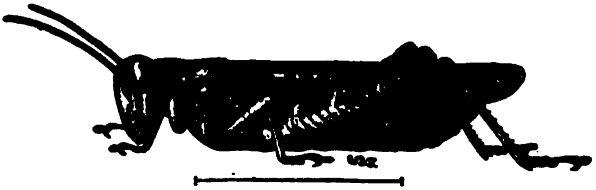

FIG. 39.—Lesser migratory locust (*Melanoplus atlanis*). (From Lugger, Minnesota Experiment Station.)

But little insect food in addition to that above discussed is consumed. A fly or a wasp is rarely secured, and one ant and a saw-fly larva were eaten. Besides insects, a small amount of other animal matter was present in the stomachs. Spiders or their egg-sacs were eaten by 2 birds and snails by 9. The latter may be taken in lieu of gravel.

MINERAL MATTER.

Only 2 adult blue grosbeaks out of a total of 38 had taken inorganic mineral matter, and the percentage of such material is only 0.63. Of 13 nestlings, 7 contained mineral matter in quantity sufficient to make the average for the whole group 8.3 percent, which is more than 13 times as much as the old birds take. So wide a discrepancy would seem to indicate that there is great difference between old and young birds in the need for this material.

YOUNG.

Among the blue grosbeaks examined are 13 young collected in Kansas in July and August. Eight of these are nestlings, and 5 are young just out of the nests, but still being fed by their parents. The percentage of animal food for the 13 young birds is 99.08; of vegetable, 0.92.

Grasshoppers constitute 74.1 percent of the food. Among them are included the lesser migratory locust (*Melanoplus atlanis*) and a large coral-winged locust (*Hippiscus*, fig. 40). The remains of as many as 16 short-horned locusts were obtained from one stomach, while another contained 14. Caterpillars, among them the purslane sphinx, compose 10.7 percent of the subsistence of the nestlings, and snails 10 percent. The remainder of the animal food consists of a weevil, a long-horned beetle, a ground beetle, a robber fly, and the eggs of a tachina fly, which were on the purslane caterpillar. It is curious that so large a proportion of the beneficial insects consumed should be in the stomachs of nestlings, but it may be that these items, which ordinarily are rarely taken, are hurriedly gathered only because of the insistent demands of the hungry young.

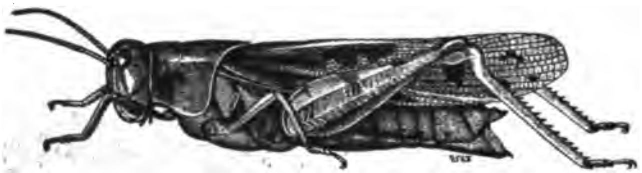

FIG. 40.—Coral-winged locust (*Hippiscus tuberculatus*). (From Lugger, Minnesota Experiment Station.)

The vegetable food consists of a few unidentified vegetable filaments and some slight remains of blackberries in two stomachs; this was the only fruit eaten by any of the birds, young or old.

SUMMARY.

Present data shows that the food of the blue grosbeak is 67.6 percent animal and 32.4 vegetable.

Grain constitutes 14.25 percent of the diet, but on account of the scattered distribution of the birds, no appreciable damage is done during most of the summer. Later, when they forage in flocks, they are said to do considerable injury. But, as noted above, the birds consume twice as much animal as vegetable matter, and even if all of the latter had been grain, instead of less than half, as is actually the case, it would have been paid for many times over.

Among the important insect pests eaten by the blue grosbeak are grasshoppers, weevils, the purslane sphinx, and the cotton cutworm. The species deserves protection for its destruction of grasshoppers alone, and when its food habits are considered in their entirety the showing unquestionably is greatly in favor of the bird.

LIST OF SEEDS, FRUITS, AND INVERTEBRATES EATEN BY THE BLUE GROSBEAK.

GRAIN AND FORAGE PLANTS.

Corn (*Zea mays*).
Oats (*Avena sativa*).
Wheat (*Triticum vulgare*).
Alfalfa (*Medicago sativa*).

WEEDS AND WILD FRUIT.

Crab-grass (*Panicum* sp.).
Yellow foxtail (*Chætochloa glauca*.)
Green foxtail (*Chætochloa viridis*).
Wild rice (*Zizania aquatica*).
Rush grass (*Sporobolus* sp.).
Smartweed (*Polygonum* sp.).
Blackberry (*Rubus* sp.).

COLEOPTERA.

Ground-beetles (Carabidæ).
Click-beetles (Elateridæ).
Leaf-beetles (Chrysomelidæ).
Bronzy wood-borers (Buprestidæ).
Lamellicorn beetles (Scarabæidæ):
    Aphodius fimetarius.
    Lachnosterna sp.
Long-horned beetles (Cerambycidæ):
    Hippopsis lemniscata.
Scarred snout-beetles (Otiorhynchidæ).
True snout-beetles (Curculionidæ).
Bill-bugs (Calandridæ):
    Rhodobænus 13-punctatus.

HEMIPTERA.

Cicadas (Cicadidæ):
    Cicada sp.
Tree-hoppers (Membracidæ).
Squash-bugs (Coreidæ).
Stink-bugs (Pentatomidæ).

ORTHOPTERA.

Short-horned grasshoppers (Acrididæ):
    Hippiscus sp.
    Melanoplus atlanis.
Long-horned grasshoppers (Locustidæ).
Crickets (Gryllidæ):
    Gryllus sp.

LEPIDOPTERA.

Hawk-moths (Sphingidæ):
    Deilephila lineata.
Owlet-moths (Noctuidæ):
    Prodenia ornithogalli.

OTHER INSECTS.

Smooth-headed ants (Formicidæ).
Sawflies (Tenthredinidæ).
Robber flies (Asilidæ).
Tachina flies (Tachinidæ).

OTHER INVERTEBRATES.

Spiders (Araneida).
Snails (Gastropoda).

RELATIONS OF GROSBEAKS AND OTHER BIRDS TO PARASITIC INSECTS.

As in the previous pages mention is made of the fact that grosbeaks to some extent feed on parasitic insects, and as many other birds have the same habit, certain phases of the subject are here briefly discussed. Parasites are useful to man because they prey upon and reduce the numbers of injurious insects. Hence to the extent that birds diminish the number of parasites they are inimical to man's interests. But there is another aspect to the interrelations of birds, parasites, and injurious insects. The attacks of parasitic insects, however numerous they may be, do not result in the immediate death of their victims, since time is required for the development of the larvæ within or upon the body of the hosts. Hence the latter, after receiving the eggs which ultimately are to prove fatal, sometimes continue their depredations, and may in a few days ruin the season's crop. Under these circumstances the parasites do no immediate good, though they serve to prevent increase of the species attacked. It is quite otherwise with birds, which instantly stop depredations by killing the insects responsible for them. Often in a few days birds extirpate a pest over a limited area, and the crop, freed from its enemies, makes successful growth. It is true that at the same time all eggs and larvæ of parasites present in the host insects also are destroyed. Though this is regrettable, the effects of the loss of the parasites must be regarded as of secondary importance, since the main purpose—getting rid of the pests—is accomplished.

Precisely the same result follows the destruction of cocoons, the burning of caterpillar nests, fumigation by hydrocyanic gas (which is exceedingly destructive to all life), and wholesale killing by contact sprays (kerosene, whale-oil soaps, and the like). These methods of destroying insects are widely recommended and extensively used, resulting in the indiscriminate destruction of beneficial and injurious insects, foe and friend alike. Moreover, there is no doubt that in spite of their indiscriminate effect, these practices result in great good. As stated above, birds are chargeable with similar destruction of useful insects along with the injurious, but it is worthy of note that the effects of their feeding have not been judged from the same standpoint nor given the benefit of doubt accorded to the work of artificial agencies. However, since it has been suggested that birds may so reduce the number of parasitic insects as seriously to restrict their beneficial services, it may be profitable to inquire into the facts of the case. There is no record of an instance in which noticeable injury has been caused through the destruction of parasites by birds, and there is much evidence going to show that this never happens. First, taking up the order Diptera, to which belong the tachina parasites (such as were found in the stomach of one blue grosbeak), the data now available show that probably less than 3 percent of the food of birds in general consists of members of this order. And there is no reason to believe that parasitic forms of this or other orders are specially sought for by birds. Since the dipterous parasites are confined to three or four families of the three score in the United States, it is not likely that the part of the 3 percent of bird food they furnish results in much injury to agriculture.

Turning to that most important group, the Hymenoptera, it is to be noted that many of them are small, some being extremely minute (as is the case with a large group of the most effective parasites, the chalcis flies), and these are very rarely found in bird stomachs. A few families of Hymenoptera (Chrysididæ, Trigonalidæ, Sapygidæ, and Mutillidæ) are characteristically parasitic on other and useful members of the order. The destruction of any of these by birds (the cuckoo-flies are taken, at least occasionally) is a benefit. The same must be said of the capture of many species belonging to other families which are guilty of the same practice. They parasitize their beneficial relatives, often destroying a large proportion of them. Moreover, even the species usually beneficial do not always stick to their rôles, but sometimes parasitize species having the same as their own normal relation to the host. All of these things tend to mitigate the injury done by birds that feed on Hymenoptera. The facts at hand show that, excluding ants (which are in no way concerned with parasites), Hymenoptera compose not more than from 3 to 5 percent of bird food in general. Of the insects composing this percentage, according to our identifications, nonparasitic forms outnumber the parasites in the proportion of about 4 to 1. Hence at most not more than 1 percent of the food consumed by all the members of our avifauna consists of parasitic Hymenoptera, taken as free-moving forms.

Proceeding now to the main point at issue, whether great numbers of parasites in the egg or larval state are eaten by birds along with the usual prey, the following statements can be made. The parasites in insect eggs (which include very many of the large superfamily Proctotrypoidea, and some others) are absolutely safe from the majority of birds, only the smaller titmice, warblers, etc., searching much for eggs. Parasites also in the cocoons and chrysalids are comparatively secure, as only few birds consume these objects. The parasites of all minute insects, like egg parasites, are exempt from danger, except from a certain contingent of the smaller birds. The parasites living upon medium-sized caterpillars, beetle larvæ, and adult insects, however, run considerable risk of becoming bird food. But even members of this group are in a measure favored, since a good proportion of the caterpillars or other insects they infest are not likely to be eaten by birds, both because they are usually discolored or otherwise abnormal in appearance and because often they are inactive, and hence escape attention. It should be stated, however, that freshly parasitized individuals are of normal appearance, and whether or not they are recognized by birds, it is certain that in the stomach such caterpillars can not be distinguished from the uninfested.

However, it is certain that, in spite of this difficulty of recognizing recently parasitized larvæ, a well-defined tendency on the part of birds to avoid these doomed insects is shown by the wholly insignificant number found in which parasitism is evident. Only the one parasitized caterpillar mentioned above, and one other eaten by a hawk, have been found in more than 40,000 stomachs examined by the Biological Survey. Hence it would seem that serious diminution in the ranks of parasites is much more logically explained by some other cause, such as the well-known pernicious activities of certain hyperparasites, than by the attacks of predaceous foes. The following extract[a] from "A Study of the Hymenopterous Parasites of the American Tent Caterpillar," by W. F. Fiske, serves to show the possibilities of this hyperparasitical activity.

> In 1896 it [the tent caterpillar] was exceedingly common, so much so as to attract attention all over the State, and it was consequently assumed that its parasites would also have increased to such an extent as to be a considerable factor in bringing about a more normal condition in 1897. But strangely enough this reasoning was found to be diametrically opposite to the facts of the case. In 1896 a great many caterpillars were destroyed by *Limneria fugitiva* [a parasite], and numbers of the characteristic cocoons of this species were collected and bred at this station. These proved in their turn to be almost entirely the prey of *Pimpla inquisitor* [a hyperparasite], and the breeding cages in which the cocoons were confined becoming filled with the adults of the hyperparasite, it was mentioned in the report of the year, and given credit for the destruction of large numbers of tent caterpillars. Thus it was the *Limneria* which proved to be the real victim, and as its cocoons were rare the next year the primary host, *Clisiocampa americana* [the tent caterpillar], was indirectly but decidedly the gainer.
>
> As one season's observations succeeded another's this case from being an exception, as was at first thought, was found to be more nearly the rule. The comparative abundance of the tent caterpillars varied greatly, it is true, but this was obviously due to other and distinct causes than this under discussion, and only a certain percentage, varying considerably from one colony to another, or to a less degree between different localities, fell a prey to the hymenopterous parasites. The parasites as a body were found to exact a certain tithe of blood, so to speak, and this being obtained would proceed to fight over its possession, passing it from one to another, from parasite to hyperparasite, until often, perhaps, there would be little more than enough left of a single large caterpillar than that sufficient to support a single small Chalcid.

It is evident from these statements that we need look no further for the enemies which so check the useful services of parasites.

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[a] Tech. Bull. 6, N. H. Agr. Exp. Sta., 1903, pp. 185-186.

Comparisons of the usefulness of parasitic insects and of predaceous species, both insects and birds, have been made to the disparagement of the latter class and in consequence the benefits conferred by parasites have sometimes been exaggerated. But in weighing the importance of these statements it should not be forgotten that essentially parasites are dependents. It is farthest from their object to exterminate their hosts, even in a limited area. This result, which in most cases means disaster to the parasite, is, on the other hand, of but little moment to predaceous insects or birds. The latter always have a wide range of prey and even if one food supply is exhausted usually there are others at hand. The best evidence that predaceous foes of insects are worthy of as high consideration as parasitic ones is afforded by the instance of the extermination, successively, by the ladybird, *Novius cardinalis*, of the cottony cushion scale in California, of the fluted scale in South Africa, and of a congeneric scale insect in the gardens of Alexandria, Egypt. These are absolutely the most important services in destroying insects ever rendered to man and were accomplished by a predaceous enemy which is chargeable with the same lack of nice discrimination with respect to parasites attributed to birds.

However, there is no necessity for belittling the services of either of the two great classes of pest destroyers. Both consume a certain proportion of insects directly injurious to man and it is more than likely that either would be hindered rather than helped by the absence of the other. Everything, indeed, points to the conclusion that from the standpoint of man's welfare the loss of either class would irreparably disturb the balance. What has been said by a noted entomologist concerning parasites, namely, that the presence of both parasites and hosts, continuing through thousands of years to the present, implies that an equilibrium is maintained enabling each to live, is just as true of predaceous enemies, both in relation to parasites and to their common prey. There can be no doubt that, even under the greatly changed conditions induced by man, the interactions of these classes tend directly toward the establishment and maintenance of a balance. It is probable that this balance can be secured at a lower level in regard to number of individuals only by direct reduction of the injurious species by man, coupled with the best possible protection of both their predatory and parasitic enemies.

GENERAL CONCLUSION.

With respect to food habits it appears that the grosbeaks form a group apart from the majority of the finch family, to which they belong. The members of this group are by no means the extreme vegetarians they are commonly supposed to be, since on the average they consume about 25 per cent of animal food. The grosbeaks, however, are even less exclusively vegetarian than others of the family and nearly half their food is animal. Moreover, the constituents of the animal dietaries of the two groups differ considerably. Nearly all finches hitherto examined have been found to avoid hairy caterpillars, but the grosbeaks eat them eagerly. True bugs generally are neglected by the smaller members of the sparrow tribe, while the grosbeaks consume on an average 7.25 percent of these strongly flavored insects. Further, while caged and hungry individuals of some of the smaller sparrows refused both the Colorado and three-lined potato beetles, cucumber and ladybird beetles, and also stinkbugs of the genus *Euschistus*, each of these insects is captured in the open by one or more, if not all, of the grosbeaks. In fact, the so-called protected fireflies, leaf beetles, and ladybirds, as also hairy caterpillars and the adaptively colored or distasteful bugs and scale insects, seem poorly defended, for all of them serve as grist for the grosbeak mill. A difference between the vegetable dietaries of the grosbeaks and other sparrows is also worthy of notice. Weed seeds form half of the annual food of the latter group, while only one of the grosbeaks devours so large a proportion, the others consuming an average of about 18 percent.

To the grosbeaks in particular, as to the sparrow family as a whole, general traits have been ascribed as characteristic which investigation fails to substantiate. For instance, the grosbeaks are found to have no special predilection for buds, notwithstanding popular opinion to the contrary. Then, too, it is generally considered that the massive grosbeak bill is especially designed to crack hard fruits and seeds, and it would appear certain that in some way it is related to peculiarities of food. Yet the smaller sparrows and the cowbirds, with much weaker bills, break all sorts of seeds as readily as the cardinal. Indeed, the food habits of the grosbeaks, as revealed by the present investigation, offer no clue to the origin of the form of bill. Its great crushing capacity appears to be utilized only on rare occasions, one cardinal, for instance, out of 500 eating a hickory nut. Practically all the food eaten by grosbeaks seemingly could be manipulated just as readily by birds with comparatively slender beaks. It is true that the curiously curved beak of the parrot-bill may be useful in securing the much relished seeds of bur grass (*Cenchrus*), but the same kind of seeds is eaten also by the straight-beaked cardinal. No doubt there is an intimate connection between the size and form and the function of the grosbeak bill, but for the key apparently we must look to past conditions of environment, for its extraordinary size and shape appear to answer no present needs.

Notwithstanding also the general similarity of bills, as well as of other points of structure, the five grosbeaks differ considerably in food habits. This divergence is beneficial to the birds, no doubt, when they occupy the same general territory, since it keeps them apart when foraging, each thus securing enough food without competing too strenuously with its neighbor. It is of great value also to man, because the birds exact tribute from the whole field of his insect enemies.

As would be expected, the cardinal and gray grosbeaks have somewhat similar tastes. They rank highest of the group as seed eaters; they consume little grain, capture a very small number of Hymenoptera, and relish weevils best among beetles and grasshoppers among other insects. The cardinal alone is very fond of wild fruit, the place of this item in the regimen of the gray grosbeak being filled by a corresponding quantity of weed seed. The rose-breasted and black-headed grosbeaks also have similar preferences, each manifesting indifference toward grasshoppers but each relishing Hymenoptera and true bugs. Fruit is held in about the same estimation by the two birds, though the blackhead is much more injurious to cultivated varieties. Both it and the rosebreast make a specialty of leaf-beetles, each selecting a single species as one of its most favored foods. The blackhead pays slight attention to grain and weed seed, but feeds ravenously on scale insects; and the rosebreast, while by no means neglecting scales, feeds more extensively on cereals and seeds. The blue grosbeak is peculiar in three respects: It shows a very strong liking for grasshoppers, for lamellicorn beetles, and a maximum avidity for grain; and it is like the gray grosbeak in almost totally neglecting fruit.

Preferences such as the above explain why one species attacks particular crops which the others never touch. Thus, from the standpoint of the fruit grower the blue grosbeak is entirely beneficial, but the grain grower sometimes has reason to execrate this species, while to him, the blackhead, which injures the fruit of his neighbor, seems innocent. But as has been shown in preceding pages the beneficial qualities predominate in both birds and "it is well to remember," as is wisely said by Wilson Flagg,[a] "that nature does not grant us a benefit without taking some compensation. We must be content to pay for the services of our useful birds by allowing them as a perquisite a certain portion of the fruits of our soil. We must pay the crow and blackbird in corn, and the robin and the cedar bird in cherries; and if it be objected that the robin tax falls disproportionately upon the fruit growers, so, on the other hand, the blackbird tax falls disproportionately upon the farmer and the corn grower. These evils, except as they can be prevented by watchfulness and ingenious contrivances that do not harm the bird, must be patiently endured for the common good."

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[a] Ann. Rep. Mass. Bd. Agr. (1861), 1862, Appendix, p. 76.

Looking beyond the confines of the individual orchard or grain field, it is apparent that the grosbeaks make small demands either on our patience or endurance. The brief season of crop pilfering is a comparatively insignificant part of the otherwise beneficial yearly life of the grosbeaks, a fact sometimes lost sight of. The importance of birds as checks upon the insect enemies of agriculture, and the fact that they are among the most valuable assets of the farm, are too well known to require proof. No one should be so blinded to his own best interests by a sense of present injury as to destroy by wholesale creatures which by every intent and provision of nature are among his best friends. The destruction of the most grievous pests known to us by birds give them a value comparable in degree, if not in kind, with that of some of the useful domestic animals, and when they are caught in mischief, they should be dealt with on the same principle as domestic stock, that is, with a view of preserving them for future service. Farm animals are not destroyed when they commit devastations; measures are taken to protect the crops from future raids by strengthening weak and broken fences. Similarly, crops should be protected against the raids of birds, and experiments have demonstrated that bird netting, tarred seed, and decoy fruit trees, among other things, may successfully be employed to this end, while at the same time the birds are preserved to turn their energies to better account in destroying insect pests.

No group of birds better deserves to be treated in this fair and practical way than the grosbeaks. The details of their useful habits, as given in the preceding pages, need not be repeated, but since a final estimate of the value of the group depends upon the exact nature of the food of its several members and their relation to agricultural interests, it is proper to restate general conclusions: The five grosbeaks studied consume on the average nine times more weed seed than grain and fruit. Moreover, they devour nineteen times more injurious than useful insects. Consequently, since their subsistence is about half animal and half vegetable, their food habits are about fourteen times more beneficial than injurious. It has been shown, furthermore, that they attack many destructive insects, even specializing on some of the greatest pests. The grosbeaks, therefore, making due allowance for the injury they do, are of great economic value, and it is evident that the farmer will derive great advantage by preserving them.

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U. S. DEPARTMENT OF AGRICULTURE

BIOLOGICAL SURVEY—BULLETIN No. 33

C. HART MERRIAM, *Chief*

THE BROWN RAT IN THE UNITED STATES

BY

DAVID E. LANTZ

ASSISTANT, BIOLOGICAL SURVEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1909

LETTER OF TRANSMITTAL.

United States Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., January 28, 1909.

Sir: I have the honor to transmit herewith a report on the Brown Rat in the United States, by Prof. David E. Lantz, and to recommend its publication as Bulletin No. 33 of the Biological Survey.

The rat is believed to be the worst mammalian pest known to man. Not only does it damage property to the extent of many millions of dollars annually, but to this pecuniary loss must be added the still greater harm it inflicts by the dissemination of the dreaded plague and other diseases. Boards of health of many maritime cities in this and other countries are now engaged in an active campaign against rats, but thus far without very gratifying success. In Japan, where the Government is awake to the seriousness of existing conditions, the number of rats destroyed annually, according to Professor Kitasato, varies "from several hundred thousand to a million. Nevertheless at the present day no appreciable diminution in the number of rodents can be noticed. Reproduction keeps pace with destruction, so that we are at a loss to know how to proceed." In order to secure effective cooperation it is important to impress on the public the need of concerted and sustained effort, and particularly the necessity of depriving these noxious animals of the lavish supply of food and shelter now unwittingly furnished them. In this connection it is believed that the present bulletin will prove helpful.

Respectfully,

C. Hart Merriam,
Chief Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.

Introduction 9
  Destructiveness of the brown rat 10
Distribution of the genus *Mus* in America 11
History of the brown rat 12
General description 13
Abundance of rats 14
Habits of rats 14
  Breeding 15
  Migrations and invasions 16
  Food of rats 18
Damage by rats 19
  Grains 19
  Poultry and eggs 22
  Game and other birds 23
  Fruits and vegetables 24
  Merchandise in stores and warehouses 25
  Flowers and bulbs 26
  Fires caused by rats 27
  Damage to buildings and furniture 28
  Miscellaneous damage 29
  Extent of damage by rats and mice in cities 30
Rats and public health 31
Utility of the rat 33
Means of repressing rats 33
  Natural enemies of the rat 34
    Hawks 34
    Owls 34
    Wild mammals 35
  Rat-proof construction 36
  Keeping food from rats 39
  Driving away rats 40
  Destroying rats 41
    Traps 41
    Poisons 44
    Domestic animals 48
    Fumigation 48
    Micro-organisms 50
  Organized efforts to destroy rats 51
    An international society 52
Summary of recommendations 53

ILLUSTRATIONS.

PLATES.

Page.

I. Fig. 1.—Brown rat. Fig. 2.—Black rat.......................... Frontispiece.

II. Fig. 1.—A cornfield devastated by brown rats. Fig. 2.—A single cornstalk ruined by brown rats.. 20

III. Copy of quarterly report of the rats destroyed in Copenhagen, October, November, and December, 1907.. 52

TEXT FIGURES.

Fig. 1. Telephone wires gnawed by rats.................................. 28

2. Method of baiting guillotine trap.................................. 42

3. Barrel traps.. 44

4. A Burmese trap.. 45

THE BROWN RAT IN THE UNITED STATES.

INTRODUCTION.

The rat is the worst mammalian pest known to man. Its depredations throughout the world result in losses amounting to hundreds of millions of dollars annually. But these losses, great as they are, are of less importance than the fact that rats carry from house to house and from seaport to seaport the germs of the dreaded plague.

Once occupying only a comparatively small part of the Old World, through the spread of commerce the brown rat has been furnished free transportation to the uttermost parts of the earth, while its fecundity, cunning, and adaptability to almost every kind of environment have enabled it to flourish and multiply wherever it has secured a foothold.

Man s antipathy to the rat is not new. For centuries the animal has been banned, and human ingenuity has been taxed to the utmost to suppress it. Innumerable devices in the way of traps, poisons, gases, and, more recently, cultures supposed to spread fatal diseases have been resorted to. Nevertheless, the pest continues to prosper, and its numbers and destructiveness keep pace with the advance of civilization. Everywhere the history of the contest is the same. Though thousands are killed, the relief is only temporary, and other thousands soon replace the slain. Therefore, if conducted along the old lines, the war promises to be never-ending.

The futility of past efforts and the lack of permanent results indicate that the real cure for the rat evil in cities, especially seaports, lies in preventive rather than curative methods. The extraordinary success that has attended the rat's struggle for existence is to be explained largely by the abundance of food and shelter furnished by man. Preventive measures should be directed to withholding these advantages. The curtailing of food is less important in its effect on the present rat population than in its certain result in lessening reproduction. Abundance of food means many young in a litter and many litters in a year; a restricted supply means fewer young and fewer litters. The most important steps, therefore, toward the suppression of the rat are:

(1) *The enactment and strict enforcement of municipal ordinances providing for the disposal of garbage and the protection of food supplies.*—Every effort should be made to instruct the public as to the necessity

for care in the disposition of refuse and the protection of food materials. Tightly closed garbage cans frequently emptied will go far toward limiting the food available for rats. Grain bins in private and public stables, now affording food and harborage for thousands of rats, and public markets and feed, provision, and grocery stores, notoriously lacking in protection against rats, should have their contents safeguarded from these animals.

(2) *The rat-proof construction of dwellings and public buildings.*—The advantages of cement in the cellars and foundations of public and private buildings are now so well understood that the rat-proofing of buildings by cement construction and other necessary measures should be no longer left to individual inclination and judgment, but should be incorporated in building regulations, and these strictly enforced. The additional expense, compared with the advantages, is trivial.

The above measures are of first importance, but they will not entirely solve the problem of rat repression. The destruction of rats, wherever they are numerous, is very important and at times absolutely necessary in the interests of public health. Hence in the following pages are given the best methods known for destroying rats, many of which have been developed by experiments and practical trials. Such methods, however, are fallible and at best inferior to preventive measures. The cutting off of the chief sources of food supply will limit the increase of the pests to a minimum, while the general construction of rat-proof buildings will deprive them of shelter and breeding places. The two measures will thus strike at the very root of the evil, and if supplemented when necessary by a vigorous campaign of destruction will prove vastly more effective, much less expensive, and productive of far more enduring results than any measures hitherto attempted.

DESTRUCTIVENESS OF THE BROWN RAT.

At the head of the rat family for destructiveness stands the brown rat (*Mus norvegicus*), called also gray rat, house rat, barn rat, wharf rat, and Norway rat. (Pl. I, fig. 1.) Like all members of the genus *Mus* found in America, the animal is not a native, but is an immigrant from the Old World. In spite of constant warfare waged against it, the brown rat has steadily increased in numbers, and has spread to almost all parts of the country reached by railways or by steamship lines. Accidentally brought to our shores after the middle of the eighteenth century, in most places it has driven out or exterminated its less robust relative, the black rat. The dominance of the brown rat is probably due to its superior strength and ferocity, its greater fecundity, its peculiar adaptability to various environments, and its more pronounced burrowing habit.

The present bulletin is intended to acquaint the public with the habits of the brown rat,[a] the nature and extent of the losses inflicted by it, and the best available methods of fighting it. It is believed that such knowledge will result in more persistent attempts, through cooperation and individual effort, to exterminate the pest, or at least permanently to reduce its numbers.

DISTRIBUTION OF THE GENUS MUS IN AMERICA.

True rats and mice belong to the Old World genus *Mus*, of which nearly 300 species have been described. Of these about seven-eighths are properly to be classed as rats and the remaining one-eighth as mice. Among all the species of *Mus* four have developed the ability to adapt themselves to such a variety of conditions as to climate and food that, carried on ships, they have established themselves in many parts of the world. These four are the only species of *Mus* that have become acclimatized in America.

The common house mouse (*Mus musculus*) found its way to America soon after the first settlement by Europeans. It is now distributed in all settled parts of North and South America, but in the extreme north it does not always survive the winters, and is therefore scarce.

The black rat (*Mus rattus*) (Pl. I, fig. 2) was carried to South and Middle America about three and a half centuries ago. The time of its arrival in the English colonies of North America is uncertain, but it was well established in the settled portions by the beginning of the eighteenth century. After the arrival of the brown rat, it began to decrease in numbers and gradually to disappear until it has become rare in most parts of the United States and Canada. It is now found in scattered colonies mostly east of the Mississippi Valley and on certain islands along the coast on both sides of the continent. It is occasionally observed in most of our seaports. The Biological Survey has specimens from Massachusetts, New Hampshire, Georgia, Florida, Alabama, California, and Washington, as well as from Mexico, Honduras, Nicaragua, and Hawaii. Also there are authentic records of its recent occurrence in Newfoundland, Quebec, Nova Scotia, New York, North Carolina, Tennessee, West Virginia, and Mississippi. In parts of South and Middle America the black rat has been more persistent and is still abundant.

The roof, or Alexandrian, rat (*Mus alexandrinus*) is similar to the black rat in form and habits, though not in color. Little is known of its history, but it is supposed to be a native of Egypt, where it is still abundant. It is almost as remarkable as the brown rat for its wandering propensities, and it is probably quite as common on seagoing ships. It has established itself in seaports in many parts of the world, mainly in warm climates, and is common near the coast in southern parts of the United States. The Biological Survey has specimens from North Carolina, Georgia, Florida, Alabama, Mississippi, Texas, Arizona, and California. In the last-named State it is abundant in the Sacramento Valley. The species is known from Lake Drummond, Va., and from Cuba, the Bermudas, Trinidad, San Domingo, Costa Rica, Nicaragua, Mexico, and Hawaii. It occurs also in many parts of South America, where it is often the dominant species.

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[a] While this paper deals primarily with the brown rat, some of the illustrative facts quoted throughout the following pages refer to the black rat (*Mus rattus*) and to the roof rat (*Mus alexandrinus*). The habits of the three species differ so little that the methods given for combating them apply to all. In some of the discussions of losses caused by rats it has not been practicable to exclude those due to the common house mouse (*Mus musculus*).

In most parts of the United States the rat common about houses and barns is the brown rat. It is larger and more robust than either the black rat or the roof rat, and differs from them considerably in habits. Unlike them, it almost always burrows in the ground under buildings and in loose soil along hedges and river banks. This habit affords better protection from enemies and, combined with the animal's greater ferocity, has enabled it to supplant the other species in temperate latitudes; but in the warmer parts of America it has not always been able to do this, and the roof rat appears to be most numerous in many localities.[a] The house mouse escapes the brown rat by taking refuge in crevices and other retreats too small for its foe to enter.

The brown rat inhabits most of the thickly populated parts of America. North of Panama it occurs from the Isthmus to the Yukon Valley and to Greenland, except on the interior table-lands and perhaps in a few sections of the South. Between the Rocky Mountains and the Sierra it is confined almost entirely to towns along the railroads. The Biological Survey is without records of its presence in Nevada, Utah, Wyoming, or Idaho. The ability of the species to withstand extreme cold is proved by the fact that it flourished in latitude 78° 37′ north, on board the ship *Advance* of Doctor Kane's second Grinnell expedition during the two winters of icebound experience. It has been able to adapt itself also to the continuous low temperatures of cold-storage plants in many of our cities.

HISTORY OF THE BROWN RAT.

The early history of the brown rat is practically unknown. The species is generally supposed to be of Asiatic origin, but we have no positive knowledge as to its native country. Various modern writers have asserted that it came originally from Persia or India. But Mr.

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[a] In the principal Asiatic seaports the brown rat is said to be often found closely associated with the other two forms.

W. T. Blanford states that the species is at present unknown in Persia, and that, as concerns India, the black rat is the generally distributed species, while the brown rat is found only along the coast and the navigable rivers.[a] This statement seems to imply that the latter is a comparatively recent immigrant into India. Early Greek and Roman writers make no mention of the rat, but it is possible that they knew the animal and included it in their references to mice.

As regards the time of the brown rat's introduction into Europe, we have two known facts. The species reached England from some eastern port about 1728 or 1729, and a little earlier it crossed the Russian frontier from Asia. Pallas, the naturalist and traveler, states that it first reached Europe from the east by way of the Volga, which river it crossed in 1727, and soon afterwards spread over the greater part of Russia.[b] In view of the statement of Blanford, already referred to, it is highly probable that previous to this migration the Asiatic home of the species was northward rather than southward of the mountain barriers of northern India. This view has been advanced by several naturalists and is further strengthened by the fact that the animal appears to flourish better in a temperate than in a tropical climate.

The brown rat is said to have first appeared in Paris in 1750. It was brought to the United States, probably from England, about the beginning of the Revolution, 1775. According to Audubon, it was unknown on the Pacific coast of the United States in 1851, although its introduction there must have occurred soon afterwards.

GENERAL DESCRIPTION.

The brown rat differs from the other two species in America in larger size, shorter head, more obtuse muzzle, smaller ears, and relatively shorter tail. The general color is grayish brown above and whitish below. The overhairs of the upper parts have black tips. The tail is usually shorter than the head and body combined, while in the other two species it is generally longer.

The black rat is usually of a sooty or plumbeous black color, paler on the underparts; while the roof rat is slightly grayer than the brown rat above and yellowish white on the feet and belly.

The skull of the brown rat shows well-marked differences from those of the other two species, but the skulls of the roof rat and the black rat are not readily distinguished from each other. Many zoologists regard the black rat as only a geographic race of the roof rat. The two forms interbreed freely.

The tame white rats of the bird stores are said to be mostly of the *Mus rattus* type; but albino and spotted specimens of the brown rat are not uncommon. The only albino rats in the collections of the National Museum and the Biological Survey are *Mus norvegicus*. Black, or melanistic, forms also of the brown rat are known.

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[a] Fauna of British India, Mammals, p. 409, 1891.

[b] Zoographica Rosso-Asiatica, Vol. I, p. 165, 1831.

The average measurements of adult specimens of the brown rat in the Biological Survey collections are as follows: Total length 415 mm. (16.4 inches); tail 192 mm. (7.1 inches); hind foot 43 mm. (1.7 inches). This rat sometimes attains a total length of 19 to 20 inches and has been known to weigh 24 to 28 ounces. The average weight of an adult is less than a pound.

ABUNDANCE OF RATS.

Few persons realize the vast numbers of rats that may inhabit a very small area. In cities, particularly, the animals swarm along river fronts and wharfs, as well as in sewers, stables, warehouses, markets, and other places where food is abundant. It is only when some of these harbors are demolished that the real numbers of the rats are discovered.

The number of rats that may harbor on an ordinary farm is astounding. In 1901 an estate of 2,000 acres near Chichester, England, was badly infested with the pests. They were systematically destroyed by traps, poisons, and ferrets. The total number destroyed under the personal supervision of the owner was 31,981; while it was estimated that tenants at the thrashing had killed fully 5,000 more. Even then the property was by no means free from rats.[a]

During the plague of rats on the island of Jamaica in 1833, the number killed on a single plantation in a year was 38,000. The injury to sugar cane on the island by the animals was at that time estimated at half a million dollars a year.[b]

An idea of the immense number of rats that may infest a country may be obtained from the report of the Indian Famine Commission presented to the English Parliament in 1881. An extraordinary plague of the animals infested the southern Deccan and Mahratta districts of India. The autumn crop of 1878 and the spring crop of 1879 were both below the average, and a great portion of the product was destroyed by rats. Rewards were paid for the destruction of the pests, and over 12,000,000 were killed.[c] While they were mostly of the black species, the illustration of abundance applies just as well to the brown rat, which is even more prolific.

HABITS OF RATS.

Close observation of the habits of wild rodents, especially of those chiefly nocturnal, is difficult. It is not surprising, therefore, that information on the life history of an animal so common as the brown rat should be meager, nor that diverse opinions about its breeding should be current. When wild rats are kept in confinement, they rarely breed, and the conclusions as to their breeding have been inferred from observations of domesticated white rats.

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[a] The Field (London), vol. 100, p. 545, 1902.

[b] New England Farmer, vol. 12, p. 315, 1834.

[c] British Medical Journal, September 16, 1905, p. 623.

BREEDING.

Observations show that climate and food supply greatly affect the rate of multiplication of rodents. The rat is no exception. It increases most rapidly in a moderately warm climate and with an abundant supply of food. Extremes of heat and cold retard its multiplication, decreasing both the number of litters produced in a year and the number of young brought forth at a time.

As already stated, the brown rat is more prolific than either of the two other species mentioned. The female brown rat generally has 12 mammæ—3 pairs of pectoral and 3 pairs of inguinal, although these numbers are by no means constant. The black rat and the roof rat have but 10 mammæ—2 pairs of pectoral and 3 pairs of inguinal, with but little tendency to vary. Records of actual observations confirm the deductions to be drawn from the above facts. At Bombay, India, during the recent investigations of the India Plague Commission, 12,000 rats were trapped and examined. The average number of embryos observed in pregnant brown rats was 8.1; the highest number, 14. The average for the black rat was 5.2; the largest number, 9.[a]

In temperate latitudes the average litter of the brown rat is probably considerably greater than the number above given. Instances of very large litters observed in England have been recorded in the Field (London). In two cases 22 and 23 young, respectively, were found in one nest, and in two other instances 17 and 19 were found in gravid females. A reliable observer residing in Washington, D. C., found 19 young rats in a single nest. The writer, on March 25, 1908, caught 6 rats in one trap, 3 of which were pregnant females, containing 10, 11, and 13 embryos, respectively. While we have hardly enough data on which to base definite conclusions for this latitude, we may safely conclude that the average litter is not less than 10.

The number of litters of young produced in a year by the brown rat is not definitely known, and probably varies with local conditions. Dehne's observations on white rats showed that in one instance an interval of only 71 days intervened between two litters from the same rat. A young female of the first litter gave birth to 6 young when she was only 103 days old.[b] Frank T. Buckland in his Curiosities of Natural History, relates that a white rat which he kept in captivity gave birth to 11 young when only eight weeks old. As gestation in rats occupies three weeks, this animal must have bred when only five weeks old. Kolazy records instances of but 25 days between successive litters of well fed albino rats.[a]

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[a] Etiology and Epidemiology of Plague, p. 9. Calcutta, 1908.

[b] Brehm's Thierleben: Säugethiere, Vol. II, p. 353, 1877.

The known facts concerning the reproduction of the brown rat in temperate latitudes may be briefly stated as follows: The animals breed from three to five times a year, each time bringing forth from 6 to 20 young. After a gestation period of 21 days, the female gives birth to her young in nests in underground burrows or under floors, stacks, lumber, wood piles, or other shelter. The young are blind and naked when born, but grow rapidly, and the females are capable of breeding when less than three months old.

If we assume that the animals breed three times a year and that the average litter is ten, and suppose that a pair and their progeny breed uninterruptedly at this rate for three years, with no deaths, the result would be as follows:

Theoretical results of three years' (nine generations) uninterrupted breeding of a pair of brown rats.

	Generation.								
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
Number of pairs breeding	1	6	36	216	1,296	7,776	46,656	279,936	1,679,616
Number of young produced	10	60	360	2,160	12,960	77,760	466,560	2,799,360	16,796,160
Total number of individuals	12	72	432	2,592	15,552	93,312	559,872	3,359,232	20,155,392

Of course, such results never occur in nature. Apparently not nearly half the rats born are females; at least, among mature rats the males greatly predominate. Then, too, the life of young rats, as well as that of the old, is a continuous struggle for existence. Disease, the elements, natural enemies, the devices and cunning of man, and even cannibalism are continually at work to reduce their numbers.

MIGRATIONS AND INVASIONS.

Migrations of rats have often been recorded. Pallas narrates that in the autumn of 1727 the brown rat arrived at Astrakhan in southern Russia from the east in such numbers and in so short a time that nothing could be done to oppose them. They crossed the Volga in large troops. The cause of the migration was attributed to an earthquake; but since similar movements of this species often occur unattended by earth disturbance, it is probable that only the food problem was involved in the migration which first brought the brown rat to Europe.

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[a] Verh. Zool. Botan. Gesel., Wien, pp. 731–734, 1871.

In nearly all countries a seasonal movement of rats from houses and barns to the open fields occurs in spring, and the return movement takes place as cold weather approaches. The movement is noticeable even in large cities.

But more general movements of rats often occur. In 1903 a multitude of migrating rats spread over several counties of western Illinois. They were noticed especially in Mercer and Rock Island counties. For several years prior to this invasion no abnormal numbers were seen, and their coming was remarkably sudden. An eyewitness to the phenomenon informed the writer that as he was returning to his home by moonlight he heard a general rustling in the field near by, and soon a vast army of rats crossed the road in front of him, all going in one direction. The mass stretched away as far as could be seen in the dim light. These animals remained on the farms and in the villages of the surrounding country, and during the winter and summer of 1904 were a veritable plague. A local newspaper stated that between March 20 and April 20, 1904, Mr. F. U. Montgomery of Preemption, Mercer County, killed 3,435 rats on his farm. He caught most of them in traps.[a]

In 1877 a similar migration occurred into parts of Saline and Lafayette counties, Mo.;[b] and in 1904, one came under the writer's observation in Kansas River valley. This valley for the most part was flooded by the great freshet of June, 1903, and for about ten days was covered with several feet of water. It is certain that most of the rats in the valley perished in this flood. In the fall of 1903 much of the district was visited by hordes of rats, which remained during the winter, and by the following spring had so increased in numbers that serious losses of grain and poultry resulted.

No doubt the majority of the so-called migrations of rodents are in reality instances of unusual reproduction or of enforced migration owing to lack of food. In England a general movement of rats inland from the coast occurs every October. This is closely connected with the closing of the herring season. During the fishing, the rodents swarm to the coast, attracted by the offal left from cleaning the herring; and when this food supply fails, they hasten back to the farms and villages.

In South America periodic plagues of rats have taken place in Parana, Brazil, at intervals of about thirty years, and in Chile at intervals of from fifteen to twenty-five years. These plagues in the cultivated lands follow the ripening and decay of the dominant species of bamboo in each country. The ripening of the seed furnishes for two or more years a favorite food for rats in the forests, where the animals multiply greatly; when this food fails they are forced to the cultivated districts for subsistence. In 1878 almost the entire crops of corn, rice, and mandioca in the State of Parana were destroyed by rats, causing a serious famine.[a]

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[a] Moline (Ill.) Evening Mail, April 25, 1904.

[b] Forest and Stream, vol. 8, p. 380, July 12, 1877.

An invasion of black rats (*Mus rattus*) in the Bermuda Islands occurred about the year 1615. In a space of two years they had increased so alarmingly that none of the islands were free from them. The rodents devoured everything which came in their way—fruit, plants, and even trees—so that for two years the people were destitute of bread. A law was passed requiring every man in the islands to set 12 traps. In spite of all efforts, the animals increased, until they finally disappeared with a suddenness which could have resulted only from a pestilence.[b]

FOOD OF RATS.

The brown rat is practically omnivorous. The statement applies as well to the black rat and the roof rat. Their bill of fare includes seeds and grains of all kinds, flour, meal, and food products made from them; fruits and garden vegetables; mushrooms; bark of growing trees; bulbs, roots, stems, leaves, and flowers of herbaceous plants; eggs, chicks, ducklings, young pigeons, and young rabbits; milk, butter, and cheese; fresh meat and carrion; mice, rats, fish, frogs, and mussels. This great variety of food explains the ease with which rats adapt themselves to almost every environment.

Experiments show that the average quantity of grain consumed by a full-grown rat is fully 2 ounces daily. A half-grown rat eats about as much as an adult. Fed on grain, a rat eats 45 to 50 pounds a year, worth about 60 cents if wheat, or $1.80 if oatmeal. Fed on beefsteaks worth 25 cents a pound, or on young chicks or squabs with a much higher prospective value, the cost of maintaining a rat is proportionately increased. Granted that more than half the food of our rats is waste, the average cost of keeping one rat is still upward of 25 cents a year.

If an accurate census of the rats of the United States were possible, a reasonably correct calculation of the minimum cost of feeding them could be made from the above data. If the number of rats supported by the people throughout the United States were equal to the number of domestic animals on the farms—horses, cattle, sheep, and hogs—the minimum cost of feeding them on grain would be upward of $100,000,000 a year. To some such enormous total every farmer, and indeed every householder who has rats upon his premises, contributes a share.

But, as will be shown later, the actual depredations of rats are by no means confined to what they eat. They destroy fully as much grain as they consume, and they pollute and render unfit for human consumption a much larger proportion of all other food materials that they attack. In addition, the damage they do to property of other kinds is often as great as that done to food supplies.

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[a] Nature, vol. 20, p. 65, 1879.

[b] Popular Science Monthly, vol. 12, p. 376, June, 1878.

DAMAGE BY RATS.

But few attempts have been made to collect statistics of damage done by noxious animals in America. The reported items of loss are so scattered and fragmentary that no accurate estimate of their amount is possible. In some parts of Europe, where agricultural holdings are small and minute economies prevail, such statistics are sometimes collected. Thus in Russia returns of the losses from predatory Carnivora in the various provinces are published annually.

A few estimates of the amount of losses from rats in foreign countries have been published. In Denmark they have been reported as amounting to 15,000,000 francs ($3,000,000) yearly.[a] In France in 1904 the total losses from rats and mice were estimated at 200,000,000 francs (nearly $40,000,000).[b] The German Ministry of Agriculture, in a circular addressed to various subordinate chambers of agriculture, states that the people of Germany suffer an annual loss through the agency of the rat of at least 200,000,000 marks ($50,000,000). Sir James Crichton-Browne, of the English Incorporated Society for the Destruction of Vermin, says that the damage done by the rat in Great Britain and Ireland "in its rural activities, to say nothing of what it does in towns and in connection with shipping, is £15,000,000 (about $73,000,000) per annum."[c]

The principal ways in which rats inflict losses in the United States are discussed under the various subheadings below.

GRAINS.

Cultivated grains may be regarded as the favorite food of rats. The animals dig the seed from the ground as soon as sown, eat the tender sprouts when they appear, and later feast upon the maturing crop. After harvest they attack grain in shock, stack, and mow, and when thrashing is over, in crib, granary, elevator, mill, and warehouse. The toll thus taken varies with the numbers of the rodents, and in some places amounts to a considerable percentage of the crop. In exceptional cases entire crops have been ruined by rats.

Indian corn.—On the whole this crop suffers greater injury from rats than any other in the United States. Besides depredations on newly sown seed, the animals attack the growing grain when in the milk stage. They climb the upright stalks and often strip the cobs clean of grain. The writer has seen whole fields of corn so destroyed, and in many cases has observed parts of fields amounting to several acres practically ruined. A writer in the American Agriculturist reported an instance in which rats destroyed three-fourths of the corn on 13 acres of land.[a] In 1905 a large portion of the crop grown on the Potomac flats, near Washington, was destroyed by rats (Plate II). The crops for 1906 and 1907 were saved by the use of traps and poisons.

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[a] Dr. Adrian Loir in Jour. d'Agri. Tropicale, vol. 3, p. 369, December 31, 1903.

[b] Jour. Board of Agri., Great Britain, vol. 2, p. 50, 1904.

[c] Jour. Inc. Soc. Dest. Vermin, vol. 1, p. 74, October, 1908.

Corn in the field, if left standing long in the shock, is liable to injury from rats. A pair of the animals will soon ruin an entire shock, destroying both grain and fodder. Such damage is sure to take place if the corn is near hedgerows, embankments, drains, or other harbors where rats are abundant; but sometimes the shocks themselves furnish shelter for the animals.

Rats often damage corn in cribs. Too frequently these receptacles for grain are built close to the ground, and rats live under the floor. They often perforate the wooden barrier and thereafter have free access to the grain. They shell the corn, eating the softer part of the kernel and wasting much more than they consume. They carry the grain to subterranean burrows and bring up into the crib moist soil, which induces mold in the corn and leaves much unfit for market or for feeding stock. A correspondent in Arkansas once wrote to the secretary of the American Institute, stating that fully half his corn was destroyed by rats after it was placed in the crib.[b]

A farmer living near Grand River, Iowa, relates the following experience:

"We had about 2,000 bushels of corn in 3 cribs to which rats ran, and they ate and destroyed about one-fourth of the corn. Much of it was too dirty to put through the grinder until it had been cleaned an ear at a time. All the time we were poisoning and trapping the rats. We killed as high as 300 rats in two days and could hardly miss them. They destroyed more than enough corn to pay taxes on 400 acres of land."[c]

The foregoing are extreme cases, but too often farmers lose a considerable portion of the crop by rat depredations. A little forethought and care in constructing or protecting the cribs would prevent such losses.

Small grains.—The rat in America has usually been considered a house and barn pest, and little notice has been taken of its destructiveness in fields. As a matter of fact, in some localities brown rats, and also common house mice, swarm in the fields, especially in summer.

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[a] Am. Agr., vol. 33, p. 300, 1874.

[b] Trans. Am. Inst., 1866–67, p. 347.

[c] Mo. Valley Farmer, April, 1907.

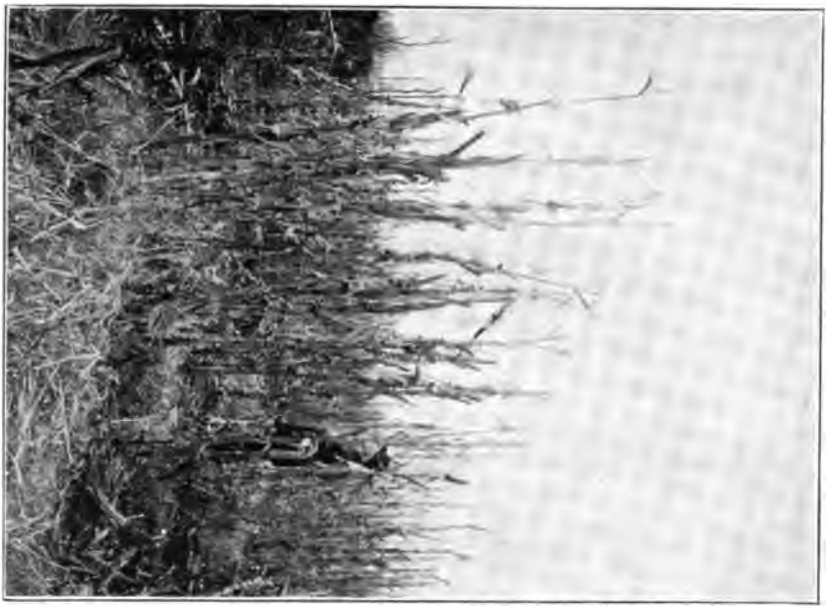

FIG. 1.—A CORNFIELD DEVASTATED BY BROWN RATS.

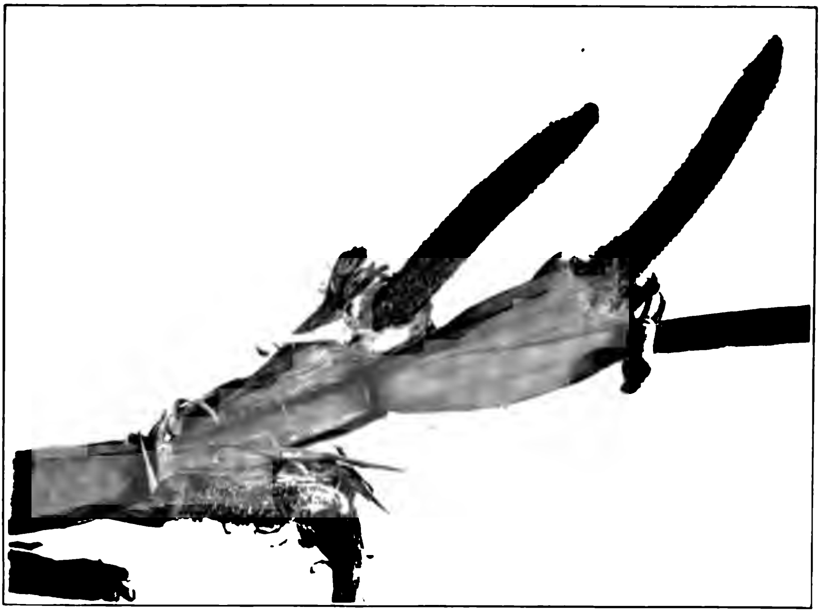

FIG. 2.—A SINGLE CORNSTALK RUINED BY BROWN RATS.

The permanency of the rat's stay in any place is merely a question of food supply. As long as cribs and stables furnish plenty, rats remain in them, but in summer the harvest field and the wheat stacks prove equally if not more attractive, and rats roam far afield.

The small grain crops—wheat, rye, barley, oats, and the like—during growth and until they leave the farmer's hands are constantly dwindling in quantity through inroads made upon them by rats, and these animals continue to prey upon them at every stage of their progress from the field to the consumer. Rats take toll not only from the portion set apart for human food, but even from feed box and manger, as well as from hog trough and outdoor field lot. Bran and chopped grains are as acceptable to rats as whole grain.

The destruction of feedstuffs by rats is a serious loss not only on the farm but in almost every city and village in the whole country. Often through carelessness or the indifference of servants, the bin or barrel in which feed is kept is left uncovered, and rats fairly swarm to the nightly feast. In some cases investigated in Washington, D. C., the loss was equal to 5 or 10 percent of the grain bought. A grocer was buying feed for two horses and several hundred rats; the horses were fed at regular intervals, the rats nearly all the time. In the cases of establishments keeping from fifty to a hundred horses, the loss of feed in the course of a year often amounts to a large item.

Rats are very fond of malt, and in malt houses and breweries constant watchfulness is necessary to prevent losses. Mills, elevators, and warehouses in which grain and feedstuffs are stored are likewise subject to invasions of the animals. Also the destruction of sacks, barrels, and bins is a large item of loss.

Rice.—Rats and mice injure rice fields in the South. The brown rat burrows freely in the dikes and is usually the most destructive species, although the introduced roof rat, the native rice rat (*Oryzomys*), and the native cotton rat (*Sigmodon*) also are injurious in some localities. A letter from Alfred Chisholm, of Savannah, written to Doctor Merriam about twenty years ago, gives some details of the abundance of rats—probably several species—in the Georgia rice fields. Mr. Chisholm says:

> Rats do almost if not quite as much damage [to rice] as birds. * * * It is a matter of fact that Col. John Screven had killed on his Proctor plantation (400 acres of rice lands) over 17,000 rats; and on the Delta plantation (1,000 to 1,200 acres) there were killed by actual count 30,000. These rats were killed during the winter and spring of the same year. During the "stretch" flow, the rats will swim out into the fields from their holes in the dikes and eat every grain of rice left exposed, their depredations being carried on mostly at night.

Arsenic was used to poison the rodents, some planters having each purchased from 50 to 100 pounds of the poison.

Sugar cane.—In nearly all countries that produce cane sugar the planters experience serious loss from rat depredations. The animals cut down and eat the ripening canes, usually selecting a fresh one at each attack. Recent complaints of serious losses to cane planters in Porto Rico and Louisiana have been received by the Biological Survey.

POULTRY AND EGGS.

The depredations of rats upon poultry are a source of serious loss. The amount of damage varies with the abundance of rats and the care taken to exclude them from the poultry yard; but the total for the entire country is always great. The loss of poultry due to rats is probably greater than that inflicted by foxes, minks, weasels, skunks, hawks, and owls combined. Since harm is usually done at night and the actual culprit is unseen, conclusions as to the identity of the marauder are often mere guesswork, and much of the damage done by rats is blamed upon other animals. Not long since, in a published account of depredations on poultry, the damage was attributed to a skunk. The statement was made that both eggs and young chicks were taken from under a sitting hen without disturbing her. This is a trick peculiar to the rat, and it is evident that a mistake was made as to the identity of the thief.

Where rats are numerous in springtime, they often prey upon young chicks, capturing them in the nest and in and around the coops. I have known them to take nearly all the chicks on a large poultry ranch, and, in the same neighborhood and over a large territory, to destroy nearly 50 percent of the season's hatching. Young ducks, turkeys, and pigeons are equally liable to attack, and where rats are numerous are safe only in rat-proof coops.

A writer in a western agricultural paper states that in 1904 rats robbed him of an entire summer's hatching of three or four hundred chicks.[a] A correspondent of another journal says, "Rats destroyed enough grain and poultry on this place in one season to pay our taxes for three years."[b] When it is remembered that the poultry and eggs produced each year from the farms of the United States have a value of over $600,000,000, it will be seen that even a small percentage of loss aggregates a large sum.

Rats destroy also many eggs both on farms and in cities. Fresh as well as incubated eggs are eaten by these rodents. Commission men and grocers complain much of depredations upon packed eggs. Those at the top of a case are broken by these animals, and parts of the yelks run down and stain the unbroken ones. Often, however, rats carry away eggs without breaking them, and display much ingenuity in getting them over obstacles, as up or down a stairway.

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[a] Homemaker (Des Moines, Iowa), May 27, 1907.

[b] Mo. Valley Farmer, April, 1907.

On a level surface the rat rolls the egg before him, but he can easily carry it between a paw and his neck and chin, while going upon three legs.

A commission merchant in Washington relates that he once stored in his warehouse 100 dozen eggs in a wooden tub with a lid of boards nailed on. Rats gnawed a hole through the tub at the top and carried away all but 28½ dozen, leaving no shells or stains to show that any had been broken.

Rats cause much annoyance and loss to poultrymen by their destruction of feed put out for fowls.

Rats are very destructive to tame pigeons, attacking especially young squabs, but destroying eggs also. They often show great cunning in finding entrances to the cages. A fancier residing in Washington, D. C., missed many of his squabs and was satisfied that the only opening by which an animal could enter was the exit at the top of the flying cage. He closed the opening and set a trap there, in which he caught a large rat. The animal had climbed the wire netting on the outside and descended it on the inside to reach the pigeons.

GAME AND OTHER BIRDS.

The rat is a most serious pest in game preserves. The propagation of game birds, both native and introduced, is now a promising industry in the United States. The rat has already proved itself a foe by destroying both eggs and young of pheasants. Abroad, the game preserver regards the rat as the worst enemy of game. A writer in Chambers' Journal says:

> In a closely preserved country at the end of an average year the game suffers more from the outlying rats of the lordship than from the foxes and the mustelines together. The solitary rats, whether males or females, are the curse of a game country. They are most difficult to detect; for in a majority of cases their special work is supposed to be done by hedgehog, weasels, or stoat.[a]

Another writer says:

> There is little doubt that of late years the worst vermin with which the generality of preservers have had to contend has been the rat. It has increased largely in numbers and in some districts become quite a plague, despite the extraordinary efforts made to deal with its ever-increasing depredations. It is unnecessary to speculate upon the probable cause of this remarkable increase. It is due entirely to the neglect of farmers, preservers, and others to adopt adequate means to deal with the pest.[b]

Our native game birds in the wild state are less subject to rat depredations than imported species. The nests of ruffed grouse are made in woodlands, which rats seldom invade The prairie hen and related species generally nest in places remote from the usual haunts of rats. The quail, or bobwhite, however, often selects a nesting site within the summer range of rats, and many a quail's egg reaches the maws of these animals.

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[a] Chambers' Journal, vol. 82, p. 64, January, 1905.

[b] Practical Game Preserving, by Wm. Carnegie ("Moorman"), p. 349, 1906.

Nests of wild ducks, woodcock, and other marsh birds are frequently destroyed by rats. Terns have been driven from their nesting grounds and entire colonies broken up in this way. Professor Mayer, of the Department of Marine Biology, Carnegie Institution of Washington, wrote, May 3, 1908, that rats had almost exterminated the colony of least terns on Loggerhead Key, Tortugas Islands. They destroyed also nearly all the gulls' and other birds' eggs laid on the key. A more recent letter from Professor Mayer states that, through systematic use of traps and poisons, all the terns hatched during the summer of 1908 were saved.

Rats eat also the eggs of nearly all kinds of ground-nesting song birds, and the real offender is seldom even suspected. Crows, jays, snakes, and skunks get much of the blame for the destruction; and while some of them share in the guilt, rats are, after all, the most serious enemies of song and game birds.

FRUITS AND VEGETABLES.

The damage done by rats to fruits and vegetables while stored in cellars and pits is well known. If any garden vegetable or common fruit is immune to their attacks, the fact has thus far escaped notice. But the extent to which the animals prey upon fruits and vegetables before they are harvested is not generally known. Rats attack ripe tomatoes, melons, cantaloupes, squashes, pumpkins, sweet corn, and many other vegetables in the field, and the depredations are often attributed to rabbits. Often both rats and rabbits take toll from the same field or garden, and the work of the former is unsuspected.

Rats are fond of nearly all small fruits, picking them up from the ground and even climbing grape vines, raspberry or blackberry canes, and currant or gooseberry bushes to obtain the ripe fruit.

The brown rat often feeds upon ripe apples, pears, cherries, and other fruits that have fallen to the ground, but it has been known to climb even to the extremities of the branches to obtain ripe apples.[a] Capt. R. R. Raymond, U. S. Army, records the following:

> Just west of old Fort Clinton, at West Point, N. Y., there was, about twenty-five years ago, a deep hollow, in the bottom of which several cherry trees grew. The hollow was used as a dump and was gradually filled level, but at the time mentioned was the home of a great many Norway rats. I often visited the hollow for cherries and frequently met rats in the trees on the same errand as myself.[b]

Dr. L. O. Howard, Chief of the Bureau of Entomology, Washington, D. C., informs the writer that during a single afternoon he shot 28 rats from the branches of a cherry tree growing in the heart of the city. The rats were feeding on the ripe fruit.

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[a] The Field (London), vol. 78, p. 660.

[b] Shields' Magazine, vol. 5, p. 123, 1907.

The brown rat is less of a climber than either the roof rat or the black rat; but in warm countries all three climb trees to a greater extent than in the north. Indeed, it is probable that one of the chief reasons why the brown rat has not been able to displace the others within the Tropics lies in the fact that they are more expert climbers. Both the roof rat and the black rat often nest in trees in hot countries, and as a matter of course feed much upon fruits. During the present attempts to abate the rat nuisance in Honolulu, Hawaii, about one-third of the rats taken have been shot from trees. While all four of the cosmopolitan species of *Mus* are common in Hawaii, those shot are chiefly the roof rat and the black rat.

Among the tropical fruits eaten by rats are oranges, bananas, figs, dates, cocoanuts, and especially the pods of cacao, from which chocolate is manufactured.

Attempts to grow dates in the southwestern United States have shown that thus far a native rat (*Sigmodon*) is the worst enemy of the date in America, but it is probable that the introduced rat will soon find its way into the plantations, displace the native species, and prove a more serious foe.

In many lands rats have proved to be enemies of the coffee-growing industry. A correspondent of The Field (London) writes to that journal as follows: "A coffee plantation in which I have an interest in Central America has recently been infested with rats to such an extent that life is almost unbearable. The place has an extent of several thousand acres, part of which is forest land, and I have noticed the branches of the bigger trees full of the pests in the daytime."[a]

Grapes grown under glass are peculiarly subject to attacks of rats. This is especially true in situations where the surrounding buildings are old and dilapidated.[b]

Rats often destroy fruits and vegetables in transit on steamboats. Tomatoes, cucumbers, sweet potatoes, bananas, oranges, grape fruit, peanuts, and other products shipped by water from the South reach their destination in northern markets with a heavy percentage of damage. Steamship companies usually ignore the claims of shippers or receivers for shortage from this cause; and their legal responsibility has not been established. In view of the practicability of destroying rats on steamers by means of fumigation, and the slight cost of building rat-proof compartments for holding the produce, it would seem that this form of loss should be entirely avoided.

MERCHANDISE IN STORES AND WAREHOUSES.

Next to the loss on grains, the largest item of loss due to rats is on miscellaneous merchandise in stores, markets, and warehouses.

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[a] A. H. G., in The Field (London), vol. 107, p. 787, May 6, 1905.

[b] Gardener's Chronicle, 1861, p. 986.

Food materials of every description are subject to attack, but the destruction of dry goods, clothing, books, leather goods, and so on, is equally serious. Many are gnawed to secure material for nests; but books and pamphlets, especially the newly bound, furnish food in the glue and paste used in the binding. Leather of certain kinds is peculiarly attractive to rats. Articles made of kid leather are often destroyed, gloves and shoes especially. Shoes made of ordinary leather are seldom injured unless they have cloth tops. Rats often gnaw old harness, attracted probably by the salt left from perspiring horses. New harnesses are seldom injured, except collars and cruppers, to which rats are attracted by the straw or flaxseed in the stuffing. A harness dealer in Washington reports a recent loss of over a hundred new cruppers, valued at about $90.

Lace curtains, silk handkerchiefs, linens, carpets, mattings, and other dry goods in large stores are much damaged by rats; some for the starch which furnishes food, others for nesting materials. Stuffs that have been soiled by rats in passing over them are often rendered unsalable.

Nearly all large dry goods and department stores have heavy losses from rats, amounting in some instances to several hundred dollars a year, in spite of unremitting efforts to destroy the animals. Grocers, druggists, confectioners, and other merchants have similar experiences. Many of them expend large sums every year fighting the pests. Most of our large cities have several so-called expert rat destroyers who operate with dogs, ferrets, poisons, and other means, and who have a large clientage among merchants and hotel managers. These pay yearly stipends of various sums, from $100 to $600, to the rat catchers to keep their premises free from rats and mice. While the stipulated service is not often performed in full, the clients usually regard the expenditures as economical.

FLOWERS AND BULBS.

Rats are recognized pests of the greenhouse and the plant-propagating pit. They attack seeds, bulbs, leaves, stems, and flowers of growing plants. Of flowering bulbs, the tulip suffers most. Hyacinths also are eaten, while narcissus bulbs are apparently immune to attack. Doubtless this is owing to the slightly poisonous qualities of narcissus.

During the winters of 1904–5 and 1905–6 rats destroyed many of the tulips grown on the Potomac flats near Washington. Sometimes several hundred bulbs were taken in a single night. Hyacinths were injured to a less extent. Traps and poisons made heavy inroads upon the numbers of rats, and probably about 60 percent of the tulips and 90 percent of the hyacinths were saved each season.

Rats attack flowering plants in the greenhouse or conservatory as well as house plants elsewhere. They eat pinks, carnations, and roses, cutting the stems off clean, and denude geraniums of both flowers and leaves. In stores and markets infested by rats carnations can not be left exposed without being eaten. Next to carnation growers, the growers of chrysanthemums are the greatest losers, for rats attack the choicest blooms even in exhibition rooms.

FIRES CAUSED BY RATS.

In the museum of the Royal United Service Institution, Whitehall, London, some years ago, a rat nest was exhibited bearing the following note:

> Rat's nest and young. This nest was set on fire by a lucifer match ignited by the old rat as she worked it into her nest. A fire was nearly caused thereby on H. M. S. *Revenge*.—Lieut. A. H. Gilmore, R. N.[a]

It is generally believed that rats and mice cause fires by igniting matches with their teeth. The testimony of chiefs of fire departments and adjusters of fire-insurance claims confirms this belief, and many specific instances have been given of fires caused in this way. A fire which resulted in the partial destruction of the Sultan's palace at Scutari, Asia Minor, in 1856, had such an origin. During 1907 the fire department of Washington, D. C., gave a similar explanation of a fire which seriously damaged a large store and its contents.

Manufacturers of matches often dip them in paraffin to protect the phosphorus. The paraffin is attractive to rats and mice, and the matches are often carried under floors and behind partitions, where they are subsequently gnawed. Paper and other combustible materials collected by the animals add to the danger of fires. Moreover, since the heads of phosphorus matches contain from 14 to 17 percent of phosphorus, it does not require actual gnawing by rats to ignite them. Hot weather, excessive heat from furnaces, or friction of any kind may effect the same result as the teeth of rats, when the matches have been carried into a nest made of combustibles.

Fires in mills and warehouses have been traced to the spontaneous ignition of oily and fatty rags or waste carried under floors by rats or mice. Cotton mills are said to be peculiarly subject to fires from this cause.

Phillip's warehouse, Church street, London, was twice set on fire and damaged by reason of gas leaks. In both instances the lead gas pipe leading to the meter had been eaten through by rats, and the escaping gas was accidentally set on fire by workmen who were searching for the leak.[b] In a similar instance of gas leak caused by rats in a London private residence, no fire resulted, but a sleeping family of four persons narrowly escaped death by asphyxiation. An inspector in the employ of the Washington Gas Light Company recounts a similar instance in that city where pipes were gnawed by rats, but fortunately it occurred when the inmates were awake.

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[a] Hardwicke's Science Gossip, vol. 5, p. 142, 1869.

[b] Hardwicke's Science Gossip, vol. 10, p. 73, 1874.

The most common way in which rats cause fires is by gnawing away the insulating covering from wires used in electric lighting, where the wires pass under floors or inside of partitions. The insulating materials are used for nests, which rats often build of combustibles placed in contact with the naked wires. Insurance companies, a few years ago, estimated the fire loss in the United States due to defective insulation of wires at $15,000,000 yearly; and since rats and mice are the chief agents in impairing the insulation after the wires are in place, a large part of the above sum must be charged to these animals.

Rats often do mischief by gnawing the insulating covering of telephone wires to obtain the paraffin which it contains. The accompanying illustration (fig. 1) is from a photograph of wires gnawed by rats August 20, 1908, where these wires passed through a partition in rooms occupied by the Biological Survey.

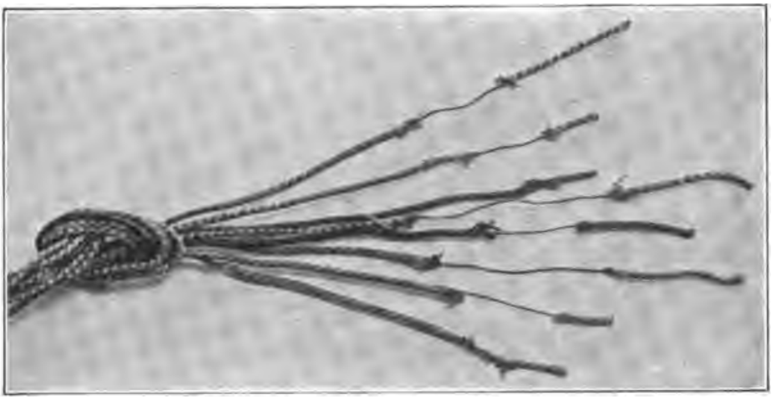

FIG. 1.—Telephone wires gnawed by rats.

DAMAGE TO BUILDINGS AND FURNITURE.

The damage to houses and furniture by rats constitutes a large item. They burrow under foundations or through the plaster in a stone wall and admit streams of water that eventually weaken or undermine the structure itself. They seem to be able to penetrate almost everything except stone, brick, cement, glass, and iron. They gnaw into a grain bin, or through a wainscoting, a floor, or a door in a single night. In the same way they enter chests, wardrobes, bookcases, closets, barrels, and boxes for the stores within. Almost every old dwelling in the country bears abundant evidence of its former or present occupancy by rats. Often depreciation in value of houses and furniture is due largely to marks left upon them by rats—marks that paint and varnish can not hide.

Damage to dwellings is even more serious. The decay of sills and floors is often hastened by contact with wet soil brought up by rats. Rats gnaw through lead pipes or wooden tanks to obtain water, and sometimes before the leak is discovered, ceilings, wall decorations, and floor coverings are flooded and practically ruined. All this is waste of a tangible kind and a constant drain on the prosperity of the people.

MISCELLANEOUS DAMAGE.

Like the muskrat, the common brown rat burrows into embankments and dams, often causing extensive breaks attended with serious loss. At State and National fish hatcheries rats cause much trouble by burrowing into embankments and gnawing through wooden tanks.

Rats often gnaw the hoofs of horses until the feet bleed. Several keepers of livery stables and dealers in horses in Washington, D. C., have had animals thus injured. Brushing the hoofs with dilute carbolic acid is a preventive.

Rats have been known to kill young lambs and pigs and to attack very fat hogs and eat holes in their bodies, causing death. Farrowing sows have been killed by rats gnawing their teats until blood poisoning resulted.[a] In a similar way, they sometimes attack the ears of pigs and shoats and cause their death by the gradual bloodletting.

Many accounts of rats attacking human beings have been published. The modern newspaper reporter seems to delight in harrowing tales of this character, most of which are the product of fertile imagination. Rats will fight if closely cornered or made desperate by lack of food, but many persons already have an unreasoning fear of the animals, which ought not to be intensified by exaggeration.

Rats often carry away valuable articles to use in constructing their nests. The following were found in a single nest: Three bed-room towels, 2 serviettes, 5 dust cloths, 2 pairs linen knickerbockers, 6 linen pocket handkerchiefs, and 1 silk handkerchief. The same rat had carried away and stored near its nest for food 1½ pounds sugar, a pudding, a stalk of celery, a beet, carrots, turnips, and potatoes.[b]

Rats in London warehouses and on shipboard do much damage to ivory in bulk. They gnaw the tusks, usually selecting the freshest and most valuable specimens.

A form of loss by rats once common on ships is not so prevalent now, owing to the more common use of metal in the construction of tanks and bulkheads. This was the perforation of wooden partitions and the damaging of merchandise and ship stores by water.

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[a] Moline (Ill.) Evening Mail, April 25, 1904.

[b] The Field (London), vol. 77, p. 46, 1891.

The extensive use of tinned provisions has also greatly diminished the losses to ship stores.

The destruction of mail sacks and their contents by rats during transportation on ships and at railway stations is a common source of loss. Grain sacks and bagging of all kinds are injured by rats more than by wear.

EXTENT OF DAMAGE BY RATS AND MICE IN CITIES.

During January and February, 1908, the writer personally interviewed about 500 business men in Washington and more than 100 in Baltimore for the purpose of securing data upon which to base an estimate of the probable amount of injury done to property by rats and mice in cities. The persons interviewed included dealers in various kinds of merchandise, feeders of horses, managers of hotels and restaurants, and manufacturers. The inquiries included all sections of the two cities and small dealers as well as large. Estimates of losses experienced during the calendar year 1907 were asked for, and, while some of the responses were mere guesses, the losses reported furnish a fairly reliable basis for averages.

Of 499 firms interviewed in Washington, 71 reported no losses, 83 were unable to give estimates, and 345 reported damages aggregating $36,100. Of the firms seen, no account was taken of about two score alien dealers in groceries or fruits who, probably because of fears of health inspection, would not admit that they were troubled by rats or mice, although evidences of rat damage were plainly visible in their stores.

The whole number of firms in the city engaged in the lines of business investigated is about 4,500. If those whose reports were considered had average losses, the total for the city would be upward of $300,000; but, to avoid exaggeration, a probable average per firm in each kind of business was calculated separately. With reasonable reductions made in this way, the total loss on merchandise in the city was estimated at $193,615. The several lines of trade not included would increase the total for the entire city to more than $200,000.

Besides the above, great loss is experienced in injury to buildings—public, business, and private. The loss on furniture and fixtures also is great. If we estimate the losses in private residences—including personal property and food destroyed, depreciation of property, and the cost of traps, poisons, cats, dogs, and other means of fighting rats—as averaging $4 for each residence, the total amounts to $200,000 a year also. It is conservative to place the entire yearly loss to the people of Washington from rats and mice at $400,000.

Inquiries in Baltimore developed the fact that, in proportion to amount of business and population, the damage from rats and mice is fully as great as in Washington. The portion of Baltimore rebuilt since the great fire of February, 1904, has been reasonably free from rats until the past year. However, many of the large modern buildings erected in the burnt district are now infested with rats. Losses from rats in the markets of Baltimore are less than in those of Washington, not because rats are scarcer, but because Baltimore enforces more stringent regulations as to the storing of goods and the arrangement of fixtures in the stalls. Based on its population and commercial importance as compared with Washington, the total losses exceed $700,000 a year. If similar conditions hold for all cities of over 100,000 inhabitants in the United States, as they probably do, depredations of rats and mice in these centers of population entail a direct loss to the residents amounting to the enormous sum of $20,000,000 annually.

RATS AND PUBLIC HEALTH.

The most serious charge against rats grows out of their relation to human health. It is now positively known that rats are chiefly responsible for the spread of bubonic plague, a malady which, in spite of modern methods of fighting it, has within the past dozen years destroyed over 5,000,000 human beings in India alone. During 1907 the deaths from plague in India were 1,200,000, and by May, 1908, the present epidemic, which started in China in 1894, had invaded all the continents and infected 51 countries of the world. The identity of plague in man with plague in the rat was proved some years ago, but the particular means by which the disease is transmitted from rat to rat and from rat to man was not clearly understood until recently. The fact that fleas carry the infection was set forth positively as early as 1902, but the conclusions of the India Plague Commission have finally removed all doubt upon the subject. The results of two years of exhaustive research were recently published in a pamphlet which thus summarizes the conclusions concerning bubonic plague:

1. Bubonic plague in man is entirely dependent on the disease in the rat.
2. The infection is conveyed from rat to rat and from rat to man solely by means of the rat flea.
3. A case of bubonic plague in man is not in itself infectious.
4. A large majority of plague cases occur singly in houses. When more than one case occurs in a house the attacks are generally simultaneous. [This proves that there is no soil infection.]
5. Plague is usually conveyed from place to place by imported rat fleas which are carried by people on their persons or in their baggage. The human agent not infrequently himself escapes infection.
6. Insanitary conditions have no relation to the occurrence of plague, except in so far as they favor infestation by rats.
7. The nonepidemic season is bridged over by acute plague in the rat, accompanied by a few cases amongst human beings.[a]

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[a] Etiology and Epidemiology of Plague, p. 93. Calcutta, 1908.

Experiments were made with two species of rat fleas, both of which were found to carry the infection. Probably all kinds of rat fleas transmit plague, while those that commonly infest dogs, cats, and man do not.

The conclusions of the Plague Commission had already been practically accepted by medical men in most parts of the world, and recent outbreaks of plague were followed by active measures for the destruction of rats. In India, as early as 1905, the authorities of the United Provinces (Agra and Oudh) began a persistent war upon the animals. Rewards were offered for killing rats, and traps were given to the people. In the four centers of population—Agra, Allahabad, Bareli, and Badaun—a total of 416,403 rats were killed before the close of the first year.[a] In Athens, Odessa, Oporto, Glasgow, and other European cities systematic, but on the whole unsuccessful, efforts were made to exterminate these animals.

Similar attempts to get rid of rats have been made since September, 1907, in some of the Pacific ports of our own country, particularly in San Francisco, where up to February, 1908, 77 deaths from plague occurred. Traps, poisons, bounties, and other means were employed to reduce the number of rodents. During the first four months of warfare under the direction of the United States Marine-Hospital Service about 130,000 of the animals were destroyed in San Francisco and vicinity. In the early months of 1908 the work of destruction was stimulated by increased bounties, and for a time the number of rats killed averaged about 7,000 per week. Up to May, 1908, 278,000 rats were captured in the city and it was estimated that half a million had been poisoned.

From May, 1908, to January 1, 1909, 115,869 rats were trapped and 9,797 were found dead in San Francisco. On an average, over 140,000 poisoned baits per week were placed, but as a matter of course the number of dead rats discovered was only a small percent of the total number killed by poison. The last rat found infected with plague bacillus was taken October 23, 1908, but no human cases of the disease have occurred in the city since January, 1908.

In Honolulu, Hawaii, active operations against rats have been reported since May 23, 1908. During the 30 weeks ending December 12, 1908, 20,288 rats were trapped and 3,528 shot from trees in the city. None of those examined was infected with plague bacillus.

But rats disseminate diseases other than bubonic plague. Trichinosis among swine is probably perpetuated entirely by rats. The occurrence of trichinæ among herbivorous animals is very rare, and in the hog can result only from its eating the flesh of animals infested with the parasite. The only two animals of the farm known to be subject to the parasite are the rat and the hog itself. Pork becomes trichinous, then, only when swine eat the flesh of infested rats or hogs. Country slaughterhouses, where rats are abundant and swine are fed on offal, are the chief sources of trichinous pork.[a]

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[a] Report on Plague in the United Provinces by Maj. Chator White, 1906.

A writer in The Spectator (London) states that septic pneumonia is sometimes the result of drinking water from shallow wells in which rats have been drowned and their bodies left to decay. He adds further that rats are "also disseminators of every kind of disease which can be conveyed into and from drains; for of all highways a rat loves a drain the best."[b] What visions of typhoid, scarlet, and malarial fevers, diphtheria, and other malignant diseases are aroused by such a statement! It is probable that many disease germs adhere to rats' feet and are thus carried to places where they threaten human health. Ptomaines are said to be sometimes conveyed to meats or other human foods in this way. On the whole, hygienic considerations furnish the strongest argument for the extermination of rats.

UTILITY OF THE RAT.

Except that to a limited extent rats act as scavengers, they render no important service to man. In former times, doubtless, their work as scavengers in cities was of considerable value, but modern methods of garbage disposal make this service insignificant.

MEANS OF REPRESSING RATS.

It is not creditable to our civilization that a creature so noxious as the rat should continue to flourish. The fact that it lives in surroundings of dirt, disorder, and waste, while it preys on the best of our productions, makes its constant increase a matter for chagrin. The animal has developed such an extraordinary degree of sagacity under persecution that attempts to exterminate it have been largely wasted. The failure of these efforts has not been due to lack of effective methods so much as to negligence and the absence of concerted action. Besides, as already stated, we have rendered our work abortive by continuing to provide subsistence and hiding places for the rat. When once these advantages are denied to the animals, persistent and concerted application of the best methods of destroying them will prove far more effective.

The more important means of fighting rats are considered under five captions: (1) Natural enemies of the rat, (2) rat-proof construction of buildings, (3) keeping food from rats, (4) driving away rats, (5) destroying rats.

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[a] Circular 108, Bureau of Animal Industry, p. 1, 1907.

[b] The Spectator, vol. 95, p. 603, October 21, 1895.

NATURAL ENEMIES OF THE RAT.

The extent to which predatory mammals and birds feed upon rodents should be more generally understood. Probably the greatest factor in the increase of rats, mice, and other destructive rodents in the United States has been the persistent killing off of the birds and mammals that prey upon them. Too often the slaughter is based upon ignorance of the animal's real economic value. Animals that on the whole are decidedly beneficial are habitually destroyed because they occasionally transgress. Thus, warfare is made on the skunk and many kinds of hawks and owls that occasionally destroy a chicken or a game bird but which habitually subsist upon harmful insects and rodents. Among the natural enemies of the rat are the larger hawks and owls, skunks, foxes, coyotes, weasels, minks, and a few other mammals. To these must be added the domestic dogs, cats, and ferrets.

HAWKS.

Several kinds of hawks feed on rats, usually during the season when the latter infest the fields; for hawks, because of persecution, do not often stay about farm buildings. Hence, ordinarily hawks have few opportunities to prey on these denizens of house and barn.

In open fields, however, rats often come out in daytime, especially in early morning and late afternoon. Hawks are then on the lookout for prey, and many a rat is killed by them. The species of hawks that most commonly feed upon rats are: The buzzard hawks (*Buteo*), including the red-tailed (*Buteo borealis* and subspecies), the red-shouldered (*B. lineatus*), the broad-winged (*B. platypterus*), and the Swainson (*B. swainsoni*); the rough-legged hawks (*Archibuteo*), two species; and probably the marsh harrier (*Circus hudsonius*).

OWLS.

In destroying rats owls are more efficient than hawks, because they hunt at night, when the rodents are most active. All American owls except the most diminutive species kill rats. Even the little screech owl (*Megascops asio*) often feeds upon the young.

Of all our owls, the barn owl (*Strix pratincola*) stands at the head in destructiveness to rats, since it often makes its home about farm buildings. Dr. A. K. Fisher, of the Biological Survey, has examined the pellets, or castings, of a pair of barn owls that live in the tower of the Smithsonian Institution in Washington and found in them skulls of 172 rats (*Mus norvegicus*). In addition, these birds had destroyed 1,285 field mice and 452 house mice.

Dr. John I. Northrop found a nest of the barn owl on Andros Island, Bahamas, which held two young birds not yet able to fly. The ground around the nest was covered with pellets which contained remains of the black rat and no other species.[a] This circumstance shows that the birds feed on whatever rodents are most abundant and most easily obtainable. In the event of a general invasion of rats in any locality where these owls stay, the birds would be most efficient aids in their destruction.

The great horned owl (*Bubo virginianus*) is the largest of our resident owls, and usually is a most useful bird. True, he captures the farmer's fowls when roosting unsheltered on fences or in trees, but such loss is easily prevented. The owl captures many rats, especially when they are plentiful. Mr. Charles Dury, of Ohio, in 1886 published a letter from O. E. Niles in which the latter states that under one nest of the great horned owl he counted 113 dead rats.[b]

The snowy owl is a rather rare winter visitor in the United States. Usually it arrives when the ground is covered with snow and ordinary food is scarce. Near barns, outbuildings, and stacks the brown rat is its chief reliance, and if undisturbed these owls will stay for several weeks in the same locality feeding on these pests.

The practice of killing hawks and owls should be discouraged. Game preservers, especially, should realize that the birds of prey would, if permitted to live, destroy rats that in the course of a year do ten times as much damage to game as the birds. The custom of paying bounties for killing birds of prey is a most unwise expenditure of public funds, harmful in its immediate results and pernicious in its influence on the community.

WILD MAMMALS.

The wild mammals that destroy rats are not numerous, and few of them resort much to localities favored by rats. Chief among those that do good work for the farmer in rat destruction are skunks, minks, and weasels. These all resort to the haunts of the rat, and are, in the main, useful. The mink is the only one that does damage enough to nearly offset its usefulness in destroying farm pests.

Skunks.—Skunks are excellent ratters, and when they take up their abode on the premises of the farmer, will speedily destroy or drive away all rats and mice. This statement applies to both the large skunks (*Mephitis*) and the little spotted skunks (*Spilogale*). Unfortunately they are seldom allowed to tenant the premises without being molested by either dogs or men. When thus disturbed, the skunks emit the characteristic secretion, which is almost their only defense against enemies. Undisturbed, they are quite inoffensive and will stay about the farm buildings until rats and mice are no longer to be had.

Skunks usually hunt by night, and hence poultry properly housed is safe from them. The larger skunks can not climb, and do not capture fowls that roost on elevated perches. Indeed, so few skunks ever kill poultry that warfare on the skunk family is not justified. Besides destroying mice and rats, skunks are invaluable to the farmer as consumers of noxious insects, particularly cutworms, army worms, tobacco worms, white grubs, May beetles, grasshoppers, crickets, and sphinx moths.

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[a] The Auk, vol. 8, p. 75, 1891.

[b] Jour. Cincinnati Soc. Nat. Hist., vol 8, p. 63, 1886.

Weasels.—Weasels are good ratters and mousers. Several of the American species come about buildings and often perform excellent service in destroying rodents. They are more destructive to poultry than the skunk, for they can enter poultry houses through smaller openings, can climb to the roosts, and usually take more than one victim at a time.

These traits make them efficient in destroying rodents also. The smaller species of weasels can follow a rat into its burrow and to nearly all its usual retreats. A single victim rarely satisfies it, and in a very short time it clears stackyard or shed of rats and mice.

Our largest species of weasel, the black-footed ferret (*Putorius nigripes*), occasionally deserts its wild haunts and comes about buildings in search of rats and mice. At Hays, Kans., during the summer of 1905, a black-footed ferret took up its abode under the board sidewalk in the business part of the town, and the squealing of its victims was frequently heard.

As concerns the destruction of poultry by weasels, the same care necessary to exclude rats from the poultry house and yard will keep out the weasel also. When so excluded, the weasel does no harm about the premises, but may be depended upon to drive out or destroy the rats.

Minks.—Minks surpass weasels in their destructiveness to poultry, and they feed on fish also. While excellent ratters, the increasing value of mink furs causes the animals to be so closely hunted that in most parts of the country they now exert little influence upon the numbers of rodent pests or upon the fortunes of the poultry grower or the fish culturist.

The mongoose.—Among the natural enemies of rats are the various species of mongoose (*Herpestes* and *Mongos*). The mongoose was introduced into Jamaica and Hawaii many years ago to stay the depredations of rats upon sugar cane and other products. While it kills many rats, it does not exterminate them, and it has proved a great scourge to poultry and native birds. It destroys also many lizards and other insectivorous animals. For these reasons its importation into the United States is prohibited by law.

RAT-PROOF CONSTRUCTION.

The best way to exclude rats from buildings, whether in city or country, is by the use of cement in construction. As the advantages of this material are coming to be generally understood, its use is rapidly extending to all kinds of buildings. Dwellings, dairies, barns, stables, chicken houses, ice houses, bridges, dams, silos, tanks, cisterns, root cellars, hotbeds, sidewalks, and curbs are now often made wholly of cement. The processes of mixing ~~and~~ laying this material require little skill or special knowledge, and workmen of ordinary intelligence can successfully follow the plain directions contained in handbooks of cement construction. Illustrated handbooks are often furnished free by cement manufacturers.

Many modern public buildings are so constructed that rats can find no lodgment in the walls or foundations, and yet in a few years, through negligence, such buildings often become infested with the pests. Sometimes drain pipes are left uncovered for hours at a time. Often outer doors, especially those opening on alleys, are left ajar. A common mistake is failure to screen basement windows which must be opened for ventilation. In whatever way the intruders are admitted, when once inside they proceed to intrench themselves behind furniture or stores, and it is difficult to dislodge them. The addition of inner doors to vestibules is an important precaution against rats. The lower part of outer doors to public buildings, especially markets, should be reinforced with light metal plates to prevent the animals from gnawing through.

In constructing dwelling houses the additional cost of making the foundations rat-proof is slight as compared with the advantages. The cellar walls should have concrete footings, and the walls themselves be laid in cement mortar. The cellar floor should be of "medium" rather than "lean" concrete, and all water and drain pipes should be surrounded with concrete. Even old cellars may be made rat-proof at comparatively small expense. Rat holes may be permanently closed with a mixture of cement, sand, and broken glass, or sharp bits of crockery or stone.

On a foundation like the one described above, the walls of a wooden dwelling also may be made rat-proof. The space between the sheathing and lath, to the height of about a foot, should be filled with concrete. Rats can not then gain access to the walls, and can enter the dwelling only through doors or windows. Screening all basement and cellar windows with wire netting is a most necessary precaution to exclude rats.

Rats sometimes gain access to houses by way of vines growing on the outer walls and reaching to open windows, and the means by which the animals come and go is a mystery to the household. Old growths of Virginia creeper or ivy often furnish such ladders for rats.

Rats often enter houses from sewers by way of soil pipes leading into water-closets. A number of instances of this kind were reported to the writer as having occurred in the city of Washington during the past year. The careful construction of drains and the use of traps that rats can not pass through will prevent such invasion of dwellings.

In cities, aside from dwellings, the sewers, wharfs, stables, and outbuildings are the chief refuges for rats. Modern sewers are used by the animals only as highways and not as permanent abodes; but old-fashioned brick sewers often furnish nesting crannies. Openings from sewers to streets may easily be screened against rats, but with modern sewers this is unnecessary.

Wharfs, stables, and outbuildings in cities should be constructed with a view to exclude rats. Cement is the chief means to this end. Old, tumble-down buildings and wharfs should not be tolerated in any city, but should be condemned and destroyed.

Almost everywhere, in country, village, and city, the wooden floors of sidewalks, areas, and porches are commonly laid upon timbers resting upon the ground. Under these floors rats are safe from most of their enemies. Only municipal action can completely remedy these conditions, but all such rat harbors should be destroyed and replaced by cement floors. Considering durability, healthfulness, and other advantages, this material is the cheapest that can be used. The floors of wooden porches should always be well above the ground. Rats often undermine brick walks or areas.

Granaries, corncribs, and poultry houses may be made rat-proof by a liberal use of concrete in the foundations and floors; or the floors may be of wood resting upon concrete. Objection has been urged against the use of concrete floors for horses, cattle, and poultry, because the material is too good a conductor of heat and the health of the animals suffers from contact with floors of this kind. In poultry houses, dry soil or sand may be used as a covering for the cement floor; and in stables, a wooden floor resting on the concrete is just as satisfactory so far as the exclusion of rats is concerned.

The common practice of setting corncribs on posts with inverted pans at the top often fails to exclude rats, because the posts are not high enough to place the lower cracks of the structure beyond reach of the animals. The posts should project at least 3 feet above the surface of the ground, for rats are excellent jumpers. But a crib built in this manner, though cheap, is unsightly.

For a rat-proof crib a well-drained site should be chosen. The outer walls, laid in cement, should be sunk about 20 inches into the ground. The space within the walls should be thoroughly grouted with cement and broken stone and finished with "rich" concrete for a floor. Upon this the structure may be built. Even the walls of the crib may be concrete. Corn will not mold in contact with them, provided there is good ventilation and the roof is water-tight.

However, there are cheaper ways of excluding rats from either new or old corncribs. Rats, mice, and sparrows may be effectually kept out by the use of either an inner or an outer covering of galvanized-wire netting of half-inch mesh and heavy enough to resist the teeth of rats. The netting in common use for screening cellar windows is suitable for covering cribs. As rats can climb the netting, the entire structure must be screened.

KEEPING FOOD FROM RATS.

The effect of an abundance of food on the breeding of rodents has already been mentioned. Well-fed rats mature quickly, breed often, and have large litters of young. Besides limiting reproduction, scarcity of food will make the measures to destroy the animals by traps, poisons, or bacterial cultures far more effective.

The general rat-proofing of buildings is the most important step in limiting the food supply of rats. But since much of the animals' food consists of garbage and other waste materials, it is not enough to bar rats from markets, granaries, warehouses, and private food stores. Garbage or offal of any kind must be so disposed of that rats can not obtain it.

In cities and towns an efficient system of garbage collection and disposal should be established by ordinances. Waste from markets, hotels, cafés, and households should be collected in covered metallic receptacles and emptied each day. Garbage should never be dumped in or near towns, but should be utilized or promptly destroyed by fire.

Rats find abundant food in country slaughterhouses; reform in the management of these is badly needed. It is a common practice to leave offal of slaughtered animals to be eaten by both rats and swine. Such places are not only centers of rat propagation, but are the chief means of perpetuating trichinæ in pork. All this should be changed by law. The offal should be promptly cremated or otherwise disposed of. There is no reason why country slaughterhouses should not be as cleanly as constantly inspected abattoirs.

Another important source of rat food is the remnants of lunches left by employees in factories, stores, and public buildings. This food, which alone is sufficient to attract and sustain a small army of rats, is commonly left in waste baskets or other open receptacles. Strictly enforced rules requiring all remnants of food to be deposited in covered vessels would make trapping far more effective.

If buildings are infested with rats, wire-screened compartments should be used for storing food. Many merchants now keep flour, seeds, meats, and the like in wire cages, and the practice should be general. Ice boxes and cold-storage rooms may be made proof against rats by an outer covering of heavy wire netting of half-inch mesh. Steamboat companies engaged in carrying high-priced southern produce to northern markets can, at small expense, protect the vegetables or fruits in screened compartments on both docks and vessels.

DRIVING AWAY RATS.

Many devices have been recommended for driving rats from premises. Some are based upon superstitions and have no merit; others are more or less practical. It should be remembered, however, that the community gains nothing when rats merely migrate from one dwelling or plantation to another. Nothing short of destruction of the animals is an adequate measure of relief. Occasionally, however, under certain circumstances it may be desirable to drive rats from a particular place, dwelling, or apartment.

Rats frequently shift their quarters, thus making it difficult to judge accurately the success of measures employed against them. They often of their own volition move to new grounds, and the change is wrongly attributed to means used to drive them away or to destroy them. This explains the diverse results that sometimes follow applications of the same remedy.

Among methods for driving away rats that have proved useful under some circumstances are the following:

1. Freshly slaked lime placed dry in all burrows and runs of rats.
2. Freshly made thin whitewash poured into the rat burrows.
3. A strong solution of copperas (ferrous sulphate) sprinkled in runs and burrow entrances.
4. Chlorid of lime, loose or wrapped in old rags, placed in burrows and runs.
5. Gas tar daubed about the burrow entrances.
6. Powdered red pepper scattered in rat runs and burrows.
7. Caustic potash placed in the burrows and runs.

The following have been so often suggested that they are mentioned here, though they have little to recommend them: Fastening a small bell to the neck of a live rat (by means of wire) and releasing the animal in the infested place; singeing or daubing with gas tar; feeding the rats plaster of Paris mixed with twice its bulk of meal, both dry. Of most of these the writer can not speak from experience. With reference to the last, however, it may be stated that caged rats ate plaster of Paris, mixed with flour or meal in various proportions, freely and without injury. The setting quality of the plaster was first carefully tested. Several days after the experiment the rats were killed and examined. Their digestive organs were in normal condition. These experiments completely disprove the often-repeated statement that plaster of Paris mixed with meal solidifies in the stomachs of rats. It may be stated further that the same rats ate freely and without harm pieces of cork and sponge that had been fried in lard. The results show that these substances, so frequently recommended, have no value in killing rats.

DESTROYING RATS.

The Biological Survey has made both laboratory and field experiments with various agencies for destroying rats. The results obtained form the chief basis for the recommendations set forth in the following pages.

TRAPS.

Owing to their cunning it is not easy to clear premises of rats by trapping. A few adults refuse to enter the most innocent-looking trap. And yet trapping, if persistently followed, is one of the most effective ways of destroying the animals. For general use the improved modern traps with a wire fall released by a baited trigger and driven by a coiled spring have marked advantages over the old forms, and many of them may be used at the same time. These traps, sometimes called guillotine traps, are of many designs, but the more simply constructed are to be preferred. Probably those made entirely of metal are the best, as they are more durable and are less likely to absorb and retain odors.

In illustration of the effectiveness of traps it may be related that about three years ago a large department store in Washington experienced heavy losses of gloves, lace curtains, and other merchandise from rat depredations. After they had made many unsuccessful attempts to abate the nuisance, the managers were advised to try the improved traps. As a result 136 rats were killed during the first 20 nights, when the losses practically ceased, and trapping has been continued in the store ever since with satisfactory results.

Guillotine traps should be baited with small pieces of Vienna sausage (Wienerwurst) or fried bacon. A small section of an ear of corn is an excellent bait if other grain is not present. The trigger wire should be bent inward to bring the bait into proper position to permit the fall to strike the rat in the neck, as shown in the illustration (fig. 2).

Other excellent baits for rats are oatmeal, toasted cheese, toasted bread (buttered), fish, fish offal, fresh liver, raw meat, pine nuts, apples, carrots, corn, and sunflower, squash, or pumpkin seeds. Broken fresh eggs are good bait at all seasons, and ripe tomatoes, green cucumbers, and other fresh vegetables are very tempting to the animals in winter. When seed, grain, or meal is used with a guillotine trap, it is placed on the trigger plate, or the trigger wire may be bent outward and the bait sprinkled under it.

When rats are numerous, the large French wire cage traps can be used to advantage. They should be made of stiff, heavy wire, well reenforced. Many of those sold in hardware stores are useless, because a full-grown rat can bend the light wires apart and escape.

Cage traps should be baited and left open for several nights until the rats are accustomed to enter them to obtain food. They should then be closed and freshly baited, when a large catch may be expected, especially of young rats. As many as 25, and even more, partly grown rats have been taken at a time in one of these traps.

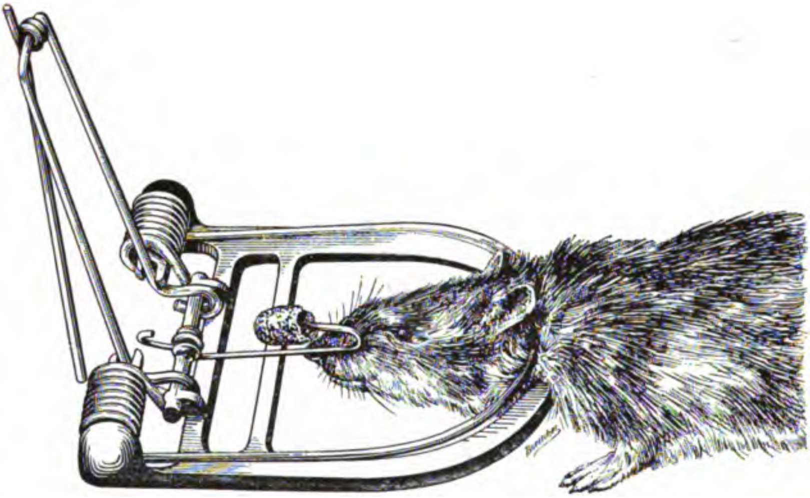

FIG. 2.—Method of baiting guillotine trap.

The editor of The Field (London), commenting on a letter from a correspondent who complained of lack of success with the cage trap, says:

> Rats are not fools and men are not always wise enough to circumvent them. We have had this trap lying in the open and not a rat would touch it, but taken up and a little refuse fish put into it and an old mat over it, we got some lovely specimens next morning. A successful trapper says that even when he gets a rat in this trap he does not disturb it, but feeds it, and sometimes he has 8 or 9 other rats come in to keep it company.[a]

The writer has had excellent success by concealing a cage trap under a bunch of hay or straw, and has found by experience that a decoy rat is useful. A commission merchant in Baltimore places the baited cage trap inside of a wooden box having a hole in one end and against which the opening of the trap is fitted. The box is then covered with trash and large catches are made.

Notwithstanding the fact that sometimes a large number of rats may be taken at a time in cage traps, in the long run a few good guillotine traps intelligently used will prove more effective.

The old-fashioned box trap set with a figure-4 trigger is sometimes useful to secure a wise old rat that refuses to be enticed into a modern trap. Better still is a simple deadfall—a flat stone or a heavy plank—supported by a figure-4 trigger. An old rat will go under such a contrivance to feed without fear.

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[a] The Field (London), vol. 89, p. 692, May 1, 1897.

The ordinary steel trap (No. 0 or 1) may sometimes be satisfactorily employed to capture a rat. The animal is usually caught by the foot, and its squealing has a tendency to frighten other rats. The trap may be set in a shallow pan or box and covered with bran or oats, care being taken to have the space under the trigger pan free of grain. This may be done by placing a very light bit of cotton under the trigger and setting as lightly as possible. In narrow runs or at the mouth of burrows a steel trap unbaited and covered with very light cloth or tissue paper is often effective.

The best bait to use in trapping is usually food of a kind that the rats do not get in the vicinity. In a meat market vegetables or grain should be used; in a feed store, meat. As far as possible, food other than the bait should be inaccessible while trapping is in progress. The bait should be kept fresh and attractive, and the kind changed when necessary. Baits and traps should be handled as little as possible. Ordinarily, traps should be frequently cleaned or smoked. The use of artificial scents, as oil of anise or rhodium, on the bait is advocated by many, but no doubt their importance has been exaggerated. The experience of the writer is not favorable to their use, but they may do some good by concealing the human odor on the trap.

Barrel trap.—About sixty years ago a writer in the Cornhill Magazine gave details of a trap by means of which it was claimed that 3,000 rats were caught in a warehouse in a single night. The plan involved tolling the rats to the place and feeding them for several nights on the tops of barrels covered with coarse brown paper. Afterwards a cross was cut in the paper, so that the rats fell into the barrel (fig. 3). Many variations of the plan, but few improvements upon it, have been suggested by agricultural writers since that time. Reports are frequently made of large catches of rats by means of a barrel fitted with a light cover of wood, hinged on a rod so as to turn with the weight of a rat (fig. 3).

Fence and battues.—In the rice fields of the Far East the natives build numerous piles of brush and rice straw and leave them for several days until many rats have taken shelter in them. A portable bamboo inclosure several feet in height is then set up around each pile in succession and the straw and brush are thrown out over the top while dogs and men kill the trapped rodents. Large numbers are killed in this way, and the plan with modifications may be utilized in America with satisfactory results. A wire netting of fine mesh may be used for the inclosure. The scheme is applicable at the removal of grain, straw, or haystacks, as well as brush piles.

In a large barn near Washington, a few years ago, piles of unhusked corn shocks were left in the loft and were soon infested with rats. A wooden pen was set down surrounding the piles in turn and the corn thrown out until dogs were able to get at the rats. In this way several men and dogs killed 500 rats in a single day.

Burmese rat trap.—The Burmese use an ingenious and simple method of trapping rats. A large jar with a weighted cover is sunken into the ground (fig. 4). A hole is punched in the side of the jar on a level with the surface of the ground and just large enough to admit a large rat. Paddy (rice) is used in the jar as a bait. A writer states that he saw 72 rats caught in one such trap the first night it was set.[a]

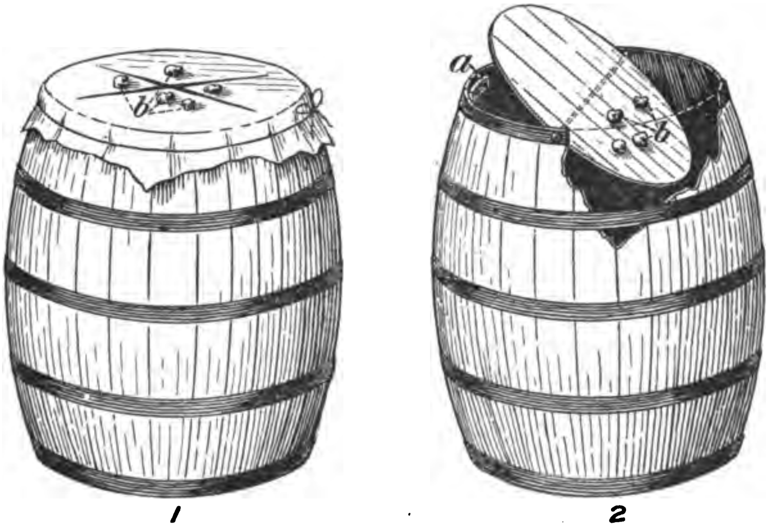

FIG. 3.—Barrel traps: 1, With stiff paper cover; 2, with hinged barrel cover; *a*, stop; *b*, baits.

POISONS.

While the use of poison is the best and quickest way to get rid of rats, the odor from the dead animals makes the method impracticable in occupied houses. Poison, however, may be effectively used in barns, stables, sheds, cribs, and other outbuildings.

Among the principal poisons that have been recommended for killing rats are barium carbonate, strychnine, arsenic, and phosphorus.

Barium carbonate.—One of the cheapest and most effective poisons for rats and mice is barium carbonate.[b] This mineral has the advantage of being without taste or smell. It has a corrosive action on the mucous lining of the stomach and is dangerous to larger animals if taken in sufficient quantity. In the small doses fed to rats and mice it would be harmless to domestic animals. Its action upon rats is slow, and if exit is possible, they usually leave the premises in search of water. For this reason the poison may frequently, though not always, be used in houses without disagreeable consequences.

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[a] The Field (London), vol. 35, p. 286, 1870.

[b] Barium carbonate, as well as some other salts of barium, is often called "barytes." In its native form it is known as "witherite." True barytes is barium sulphate, which is too insoluble for practical use as a poison for rats.

Barium carbonate may be fed in the form of dough composed of four parts of meal or flour and one part of the mineral. A more convenient bait is ordinary oatmeal with about one-eighth of its bulk of the mineral, mixed with water into a stiff dough. A third plan is to spread the barium carbonate upon fish, toasted bread (moistened), or ordinary bread and butter. The prepared bait should be placed in rat runs, a small quantity—as a teaspoonful—at a place. If a single application of the poison fails to kill or drive away all rats from the premises, it should be repeated with a change of bait.

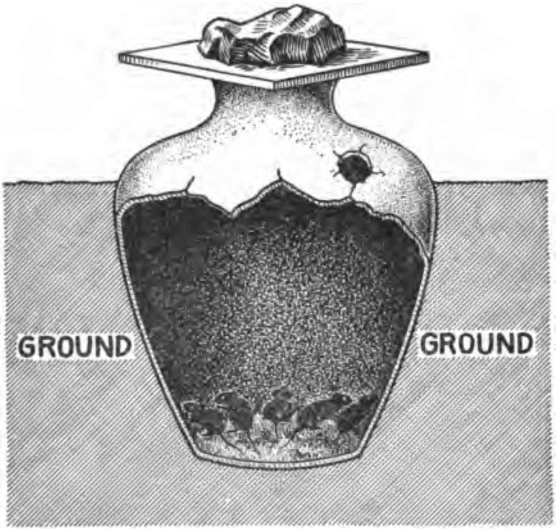

FIG. 4.—A Burmese trap.

Strychnine.—Strychnine is too rapid in action to make its use as a poison for rats desirable in houses, but elsewhere it may be employed effectively. Strychnia sulphate is the form best adapted for use. The dry crystals may be inserted in small pieces of raw meat, Vienna sausage, or toasted cheese, and these placed in rat runs or burrows; or oatmeal may be moistened with a strychnine sirup, and small quantities laid in the same way.

Strychnine sirup is prepared as follows: Dissolve a half ounce of strychnia sulphate in a pint of boiling water; add a pint of thick sugar sirup and stir thoroughly. A smaller quantity of the poison may be prepared with a proportional quantity of water. In preparing the bait it is necessary that all the oatmeal should be moistened with sirup. Wheat is the most convenient alternative bait. It should be soaked over night in the strychnine sirup.

The bitterness of strychnine often prevents rats from eating baits containing the crystals. This trouble may sometimes be overcome by first feeding the baits without the strychnine for several successive nights until suspicion is allayed.

Arsenic.—Nearly all commercial rat poisons have either arsenic or phosphorus as a basis; and while many of them are effective, the poison is often present in quantities too small to be fatal to rats. It has been proved by experiment that sometimes rats have great power of resistance to some poisons, particularly to arsenic. Yet arsenic is an excellent rat poison, as is shown by its continued popularity. Its cheapness commends it to favor; yet the experiments of the Biological Survey show that strychnine, measured by the results obtained, is really the cheaper poison for most rodents.

Powdered white arsenic (arsenious acid) may be fed to rats in nearly any of the baits mentioned under barium carbonate and strychnine. It has been used successfully when rubbed into fresh fish or spread on buttered toast. Another method is to mix twelve parts by weight of corn meal and one part of arsenic with whites of eggs into a stiff dough.

An old formula for poisoning rats and mice with arsenic is the following, adapted from an English source:

Take a pound of oatmeal, a pound of coarse brown sugar, and a spoonful of arsenic. Mix well together and put the composition into an earthen jar. Place a tablespoonful at a place in runs frequented by rats.

Phosphorus.—This is probably the most widely used poison for rats and mice, and undoubtedly it is effective when given in an attractive bait. The phosphorus paste of the drug stores is usually dissolved yellow phosphorus mixed with glucose or other substances. The proportion of phosphorus varies from one-fourth percent to 4 percent. The first amount is too small to be always effective, and the last is dangerously inflammable. When home-made preparations of phosphorus are used, there is much danger of burning the person or of setting fire to crops or buildings. In the western States many fires have resulted from putting out home-made phosphorus poisons for ground squirrels, and entire fields of ripe grain have been destroyed in this way. Even with the commercial pastes the action of sun and rain upon them changes the phosphorus and leaches out the glucose until a highly inflammable residue is left.

It is often claimed that when phosphorus is eaten by rats or mice it dries up or mummifies the bodies so that no odor results. The statement has no foundation in fact. Equally misleading is the statement that rats poisoned with phosphorus do not die on the premises. Owing to its slower operation, no doubt a larger proportion escape into the open before dying than when strychnine is used.

The Biological Survey does not recommend the use of phosphorus as a poison for rodents.

Caution.—In the United States there are few laws which prohibit the laying of poisons on lands owned or controlled by the poisoner. Hence it is all the more necessary to exercise extreme caution to prevent accidents. In several States notice of intention to lay poison must be given to persons living in the neighborhood. Poison for rats should never be placed in open or unsheltered places. This applies particularly to the use of strychnine or arsenic on meat.

Poison in poultry houses.—For poisoning rats in buildings and yards occupied by poultry, the following method is recommended: Two wooden boxes should be used, one considerably larger than the other, and each having two or more holes in the sides large enough to admit rats. The poisoned bait should be placed on the bottom and near the middle of the smaller box, and the larger box should then be inverted over the other. Rats thus have free access to the bait, but fowls are excluded.

The following methods of poisoning rats are quoted as useful under certain circumstances:

"I took a box, made several holes in it, turned it upside down, mixed strychnine and cheese together and put it under the box. I then placed a heavy weight on the box so that no domestic animal could get at it and put it in the granary and corncrib. This poison is best because it acts so quickly that rats do not have time to get back to their holes or crawl where any domestic animal can get at them and they can be gathered up and buried." [a]

A writer in the Agricultural Gazette used barium carbonate on herrings, after first feeding the rats liberally on herrings to give them confidence. After a couple of nights' feeding, the poisoned herrings were substituted. The barytes was rubbed into the herrings with a stick. Many rats were killed.[b]

Use any kind of wooden box, like an old packing case. Make three or four holes in each box large enough to allow a rat to enter. Feed meal for several days; then omit for one day. Then mix arsenic with the meal.[c]

To destroy rats on farms.—Each evening when the cows are milked place a little fresh milk in a shallow pan where the rats can get it.

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[a] A. E. L. in Mo. Valley Farmer for April, 1907.

[b] American Agriculturist, vol. 9, p. 257, August, 1850.

[c] The Field (London), vol. 96, p. 624, October 30, 1900.

Continue this for a week or more until the rats get bold and impatient to get at the milk. Then mix arsenic with the milk and await results. This plan is said to entirely clean a barn of rats.[a]

DOMESTIC ANIMALS.

Among the domestic animals often employed to kill rats are the familiar dog, cat, and ferret.

Dogs.—The value of dogs as ratters can not be appreciated by persons who have had no experience with a trained animal. The ordinary cur and the larger breeds of dogs seldom develop the necessary qualities for ratters. Small Irish, Scotch, and fox terriers when properly trained are superior to other breeds, and under favorable circumstances may be relied upon to keep the farm premises reasonably free from rats.

With some preliminary training most terriers learn to hunt rats independently and thus become doubly useful on the farm. Several terriers owned in Washington are said to have destroyed over 1,000 rats each, and the owner of one of them states that his dog has killed that number in one year. A young terrier kept in the National Capitol is said to have destroyed over 400 rats in that building.

Cats.—However valuable cats may be as mousers, few of them learn to catch rats. The ordinary house cat is too well fed and consequently too lazy to undertake the capture of an animal as formidable as the brown rat. Birds and mice are much more to its liking.

Ferrets.—Tame ferrets, like weasels, are inveterate foes of rats, and can follow the rodents into their retreats. Under favorable circumstances they are useful aids to the rat catcher, but their value is greatly overestimated. For effective work they require experienced handling and the additional services of a dog or two. Dogs and ferrets must be thoroughly accustomed to each other, and the former must be quiet and steady instead of noisy and excitable. The ferret is used only to bolt the rats, which are killed by the dogs. If unmuzzled ferrets are sent into rat retreats, they are apt to make a kill and then lie up after sucking the blood of their victim. Sometimes they remain for hours in the burrows or escape by other exits and are lost. There is danger that these lost ferrets may adapt themselves to wild conditions and become a pest by preying upon poultry and birds.

FUMIGATION.

Rats may be destroyed in their burrows in the fields and along river banks, levees, and dikes by the use of carbon bisulphid. A wad of cotton or other absorbent material is saturated with the liquid and then pushed into the burrow, the opening being packed with earth to prevent the escape of the gas. All animals in the burrow are asphyxiated. Fumigation in buildings is rarely effective, because it is difficult to confine the gases. Moreover, when effective, the odor from the dead rats is highly objectionable.

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[a] E. H. Reihl, in Colman's Rural World, vol. 61, p. 27, January 29, 1908.

Chlorin, carbon monoxid, sulphur dioxid and hydrocyanic acid are the gases most used for destroying rats and mice in sheds, warehouses, and stores. Each is effective if the gas can be confined and made to reach the retreats of the animals. Owing to the great danger from fire incident to burning charcoal or sulphur in open pans, a special furnace provided with means for forcing the gas into the compartments of vessels or buildings is generally employed.

Hydrocyanic-acid gas is effective in destroying all animal life in buildings. It has been successfully used to free elevators and warehouses of rats, mice, and insects. However, it is so dangerous to human life that the novice should not attempt fumigation with it, except under careful instructions. Directions for preparing and using the gas may be found in "Hydrocyanic-acid Gas against Household Insects," by Dr. L. O. Howard.[a]

Carbon monoxid is rather dangerous, as its presence in the hold of a vessel or other apartment is not manifest to the senses, and fatal accidents have occurred during its employment to fumigate vessels.

Chlorin gas has a strong bleaching action upon textile fabrics and for this reason can not be used in many situations.

Sulphur dioxid also has a bleaching effect upon textiles, but less marked than that of chlorin and ordinarily not noticeable with the small percentage of the gas it is necessary to use. On the whole, this gas has many advantages as a fumigator and disinfectant. It is successfully employed also as a fire extinguisher on board vessels.

The port regulations for destroying rats to prevent the introduction of plague and to disinfect merchandise and personal effects of passengers have generally been made to conform to the opinion of health officers that thorough fumigation with sulphur dioxid forced into every part of a ship meets all requirements, and the long delays of quarantine are thus avoided. A number of important steamship companies have fitted their vessels with special apparatus for generating the gas and forcing it into the compartments of their ships, and the authorities of some ports have fitted the docks with such apparatus for use on all incoming vessels.

While the chief object of the port regulations for disinfecting ships is to prevent the introduction of plague and similar diseases, the advantages of having vessels free from rats and other vermin are of sufficient importance to warrant the outlay for apparatus. The numbers of rats on shipboard and the amount of mischief they are capable of are not always appreciated. A French maritime journal is authority for the statement that in May, 1901, after the steamship *Minnehaha* of the Atlantic Transport Company had been disinfected at the London dock by the use of sulphur dioxid over 1,300 dead rats were found in the holds. The vessel had been in commission only about nine months, carrying flour, grain, and provisions between New York and London, and the finding of so many rats was a complete surprise to the ship's officers.

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[a] Circular 46, Bureau of Entomology, U. S. Dept. of Agric., 1907.

MICRO-ORGANISMS.

At irregular intervals when rodents become overabundant, contagious diseases break out and destroy large numbers. Such diseases have been known to occur among ground squirrels, prairie dogs, rabbits, lemmings, house mice, field mice, and rats. They occur also, occasionally, where numbers of the animals are brought together in confined quarters. Observations of such epidemics have encouraged bacteriologists to experiment in inducing diseases artificially for the purpose of destroying rodent pests.

The problem of the bacteriologist is to find an organism that will destroy a given species by contagious disease, and yet be harmless to all other animals, whether wild or domesticated. From a scientific standpoint some progress has been made toward the solution of such problems, but practical results are still lacking. The rat has been the subject of more experiments than any other animal, but attempts to destroy it by epidemics have not yet advanced beyond the experimental stage.

Several micro-organisms, or bacteria, have been exploited in Europe and America for destroying rats. A number are on the market in the United States. The Biological Survey has made laboratory and field experiments with some of them, and has also received many reports from others who have tried the cultures in a practical way. The results are by no means uniform, although the majority are negative. The cultures tested by the Survey have given poor results.

The chief defects to be overcome before the cultures can be recommended for general use are—

1. The virulence is not great enough to kill a sufficiently high percentage of rats that eat food containing the micro-organisms.
2. The virulence decreases with the age of the cultures. They deteriorate in warm weather and in bright sunlight.
3. The diseases resulting from the micro-organisms are not contagious and do not spread by contact of diseased with healthy animals.
4. The comparative cost of the cultures is too great for general use. Since they have no advantages over the common poisons, except that they are harmless to man and other animals, they should be equally cheap; their actual cost is much greater. Moreover, con-

sidering the skill and care necessary in their preparation, it is doubtful if the cost can be greatly reduced.

However, the possibilities in the use of contagious diseases for destroying rats have not been exhausted. It is not improbable that a virulent bacterium, pathogenic for rats and similar rodents only, exists, and that vigilant search will discover it. Bacteriological science is in its infancy and may be expected to make further discoveries of great economic importance. A rat disease, truly contagious, harmless to other animals, and capable of being used at will would be a boon worth many millions of dollars annually to the people of the United States.

ORGANIZED EFFORTS TO DESTROY RATS.

The necessity of cooperation and organization in the work of rat destruction should not be overlooked. To destroy all the animals on the premises of a single farmer in a community has little permanent value, since they are soon replaced from near-by farms. If, however, the farmers of an entire township or county unite in efforts to get rid of rats, much more lasting results may be attained. Such organized efforts repeated with reasonable frequency are very effective.

Cooperative efforts to destroy rats have taken various forms in different localities. In cities municipal employees have occasionally been set at work hunting rats from their retreats with at least temporary benefit to the community. Thus, in 1904, at Folkestone, England, a town of about 25,000 inhabitants, the corporation employees, helped by dogs, in three days killed 1,645 rats.[a]

Side hunts in which rats are the only animals that count in the contest have sometimes been organized and successfully carried out. At New Burlington, Ohio, a rat hunt took place November 26, 1866, in which each of the two sides killed over 8,000 rats, the beaten party serving a Thanksgiving banquet to the winners.[b]

At about the same period county agricultural societies sometimes offered prizes to the family presenting the largest number of rat tails as evidence that the animals had been destroyed. Even as late as May 2, 1907, in one of the counties of Kentucky, by general consent, the day was set apart for killing rats, and, according to newspaper reports, was quite generally observed.

There is danger that organized rat hunts will be followed by long intervals of indifference and inaction. This may be prevented by offering prizes covering a definite period of effort. Such prizes accomplish more than municipal bounties, because they secure a friendly rivalry which stimulates the contestants to do their utmost to win.

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[a] The Field (London), vol. 104, p. 98, July 16, 1904.

[b] American Naturalist, vol. 26, p. 8, January, 1867.

In England and some of its colonies contests for prizes have been organized to promote the destruction of the European house sparrow, but many of the so-called "sparrow clubs" are really sparrow and rat clubs, for the destruction of both pests are avowed objects of the organization. A sparrow club in Kent, England, secured the destruction of 28,000 sparrows and 16,000 rats in three seasons, by the annual expenditure of but £6 ($29.20) in prize money.[a] Had ordinary bounties been paid for this destruction, the tax on the community would have been about £250 (over $1,200).

AN INTERNATIONAL SOCIETY.

Perhaps the most extensive campaign ever organized against rats is that undertaken by L'Association Internationale pour le Destruction Rationelle des Rats, a society which originated in Denmark and was organized through the influence of a civil engineer named Emil Zuschlag. The purposes of the society are to spread information concerning the mischief done by rats and to carry on a general campaign for their destruction. The influence of the organization has already borne fruit in increased activity in fighting rats in Denmark, Sweden, Saxony, and other countries. In Denmark and Sweden a system of small bounties for killing rats has for several years been in general operation in some of the larger cities, and the Danish Parliament has made appropriations to assist municipalities throughout that Kingdom in paying premiums for the work of destruction. General supervision of the work is in the hands of the society, which receives regular quarterly reports of progress made in the various municipalities. The form of report is shown in Plate III, which is an exact copy of the report for the city of Copenhagen for the last quarter of 1907. The premiums paid are usually small—from 5 to 10 öre (1⅓ to 2⅔ cents) for each rat. Mr. Zuschlag recently reported that under the Danish law appropriating government funds for the prosecution of the society's work, 1,141,293 rats were destroyed during the first year, ending July 1, 1908.[b]

In the city of Copenhagen and its suburbs the campaign began in December, 1899, and 103,000 rats were destroyed during the first eighteen weeks. The premium paid was 10 öre for each rat, but other expenses brought the total cost to about $3,450. The society estimated that during one year 100,000 rats would commit depredations upon property amounting to $97,820; by the work of destruction the city had, therefore, been saved the sum of $94,370.[c] During

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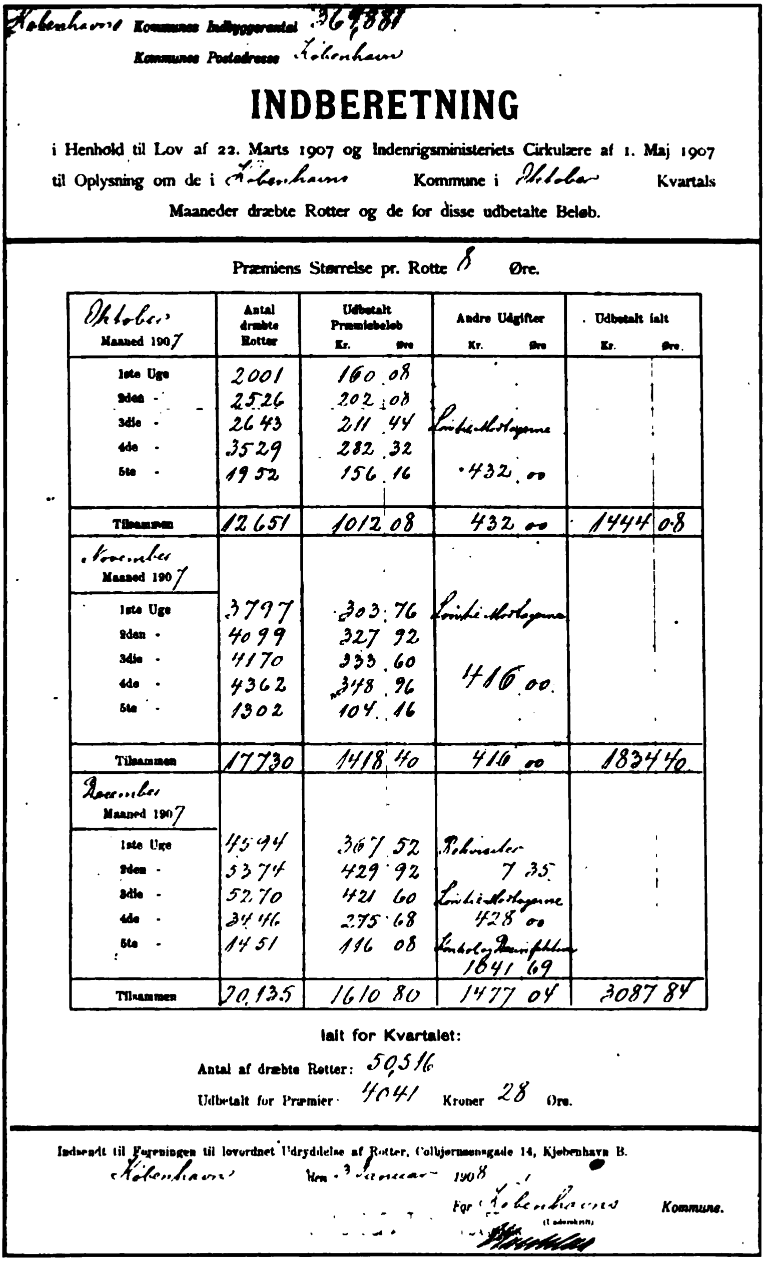
[a] Jour. Board of Agr. Great Britain, vol. 9, p. 342, 1902.

[b] Jour. Inc. Soc. for Dest. Vermin, vol. 1, p. 32, October, 1908.

[c] Le Rat Migratoire, Emil Zuschlag, p. 62, Copenhagen, 1908.



Københavns Kommunes Indbyggerantal 364,881
Kommunes Postadresse København

INDBERETNING

i Henhold til Lov af 22. Marts 1907 og Indenrigsministeriets Cirkulære af 1. Maj 1907 til Oplysning om de i Københavns Kommune i Oktober Kvartals Maaneder dræbte Rotter og de for disse udbetalte Beløb.

Præmiens Størrelse pr. Rotte 8 Øre.

Oktober Maaned 1907	Antal dræbte Rotter	Udbetalt Præmiebeløb Kr.	Øre	Andre Udgifter Kr.	Øre	Udbetalt ialt Kr.	Øre
1ste Uge	2001	160	08				
2den -	2526	202	08				
3die -	2643	211	44	[illegible]			
4de -	3529	282	32				
5te -	1952	156	16	432	00		
Tilsammen	12651	1012	08	432	00	1444	08
November Maaned 1907							
1ste Uge	3797	303	76	[illegible]			
2den -	4099	327	92				
3die -	4170	333	60				
4de -	4362	348	96	416	00		
5te -	1302	104	16				
Tilsammen	17730	1418	40	416	00	1834	40
December Maaned 1907							
1ste Uge	4594	367	52	Rekvisiter			
2den -	5374	429	92	7	35		
3die -	5270	421	60	[illegible]			
4de -	3446	275	68	428	00		
5te -	1451	116	08	[illegible] 1641	69		
Tilsammen	20135	1610	80	1477	04	3087	84

Ialt for Kvartalet:

Antal af dræbte Rotter: 50516
Udbetalt for Præmier 4041 Kroner 28 Øre.

Indsendt til Foreningen til lovordnet Udryddelse af Rotter, Colbjørnsensgade 14, Kjøbenhavn B.

København den 3 Januar 1908

For Københavns Kommune.
(Underskrift)

COPY OF QUARTERLY REPORT OF THE RATS DESTROYED IN COPENHAGEN, OCTOBER, NOVEMBER, AND DECEMBER, 1907.

the last two quarters of 1907, in the same city, 83,832 rats were killed. The premiums, 8 öre per rat, amounted to $1,787.36 and the other expenses to $1,198.60, a total of $2,985.96.

In the city of Stockholm, Sweden, the organized work of destroying rats began in February, 1901, and has progressed steadily for the past seven years. The premium paid is 5 öre per rat and the total number of animals upon which the bounty was paid during the first six years follows: 1901 (11 months), 146,191 rats; 1902, 96,443 rats; 1903, 95,348 rats; 1904, 106,263 rats; 1905, 103,233 rats; 1906, 92,037 rats; 1907, 72,282 rats; a total for seven years of 711,797 rats, upon which the premiums amounted to about $9,540. The results here given are hardly encouraging to those who hope for speedy extermination of these pests in large cities. It shows that the animals reproduce almost as rapidly as they are destroyed under the stimulus of a very small premium.

The Danish Society for Rat Extermination has a membership of over 2,000 of the leading citizens of the Kingdom. It has interested and enrolled in its work leading men throughout Europe, and will undoubtedly exert a potent influence for good upon the entire world. As a public policy in America the wisdom of offering bounties for the destruction of noxious animals is open to question, but the Danish society does not confine its work to advocating a single plan for rat destruction. Its chief importance lies in its ability to awaken general interest in the work and to secure cooperation and system in carrying out definite plans.

The influence of the Danish society has been manifested recently in the organization in England of the Incorporated Society for the Destruction of Vermin. The objects of attack are not only rats and mice, but also sparrows, ticks, fleas, mosquitoes, and flies. The immediate activities of the society are to be directed against the brown rat, of which species the society estimates that 40,000,000 exist in the British Islands. The first number of a quarterly periodical devoted to the objects of the society appeared in October, 1908, and considerable interest has already been aroused.

SUMMARY OF RECOMMENDATIONS.

The following are important aids in limiting the numbers of rats and reducing the losses from their depredations:

1. Protection of our native hawks, owls, and smaller predatory mammals—the natural enemies of rats.

2. Greater cleanliness about stables, markets, grocery stores, warehouses, courts, alleys, and vacant lots in cities and villages, and like care on farms and suburban premises. This includes the storage of waste and garbage in tightly covered vessels and the prompt disposal of it each day.

3. Care in the construction of buildings and drains so as not to provide entrance and retreats for rats, and the permanent closing of all rat holes in old houses and cellars.

4. The early thrashing and marketing of grains on farms, so that stacks and mows shall not furnish harborage and food for rats.

5. Removal of outlying straw stacks and piles of trash or lumber that harbor rats in the fields.

6. Rat-proofing of warehouses, markets, cribs, stables, and granaries for storage of provisions, seed grain, and feedstuffs.

7. Keeping effective rat dogs, especially in city warehouses.

8. The systematic destruction of rats, whenever and wherever possible, by (*a*) trapping, (*b*) poisoning, and (*c*) organized hunts.

9. The organization of "rat clubs" and other societies for systematic warfare against rats.

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Issued August 8, 1910.

U. S. DEPARTMENT OF AGRICULTURE

BIOLOGICAL SURVEY—BULLETIN No. 34

C. HART MERRIAM, *Chief*

BIRDS OF CALIFORNIA

IN RELATION TO THE
FRUIT INDUSTRY

PART II

By F. E. L. BEAL
Assistant, Biological Survey

WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

LETTER OF TRANSMITTAL.

U. S. **Department of Agriculture,**
Biological Survey,
Washington, D. C., February 25, 1910.

Sir: I have the honor to transmit herewith for publication as Bulletin No. 34 of the Biological Survey, Part II of the Birds of California in Relation to the Fruit Industry, by Prof. F. E. L. Beal. This, the final part of the report, treats of some of the most important California birds from the standpoint of the orchardist and the farmer. Careful study of the food habits of birds that frequent orchards and their vicinity shows that most of the species are beneficial, and that without their aid the difficulty and expense of raising fruit would be enormously increased; still a few species under certain circumstances are harmful and need to be held in check.

Respectfully,

C. Hart Merriam,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.

Introduction.. 7

California quail.. 9

Woodpecker family.. 14

- Hairy woodpecker.. 15
- Downy woodpecker.. 17
- Nuttall woodpecker.. 19
- Red-breasted sapsucker.. 21
- California woodpecker.. 22
- Red-shafted flicker.. 25
- Other woodpeckers.. 28

Flycatcher family.. 29

- Ash-throated flycatcher.. 29
- Arkansas kingbird.. 32
- Cassin kingbird.. 34
- Say phoebe.. 35
- Black phoebe.. 36
- Western wood pewee.. 39
- Western flycatcher.. 41
- Other flycatchers.. 44

Horned lark.. 44

Jay family.. 47

- Steller jay.. 47
- California jay.. 50

Blackbird, oriole, and meadowlark family.. 56

- Bicolored redwing.. 56
- Other redwings.. 59
- Brewer blackbird.. 59
- Western meadowlark.. 65
- Bullock oriole.. 68

Sparrow family.. 71

- Willow goldfinch.. 71
- Green-backed goldfinch.. 73
- Intermediate and Nuttall sparrows.. 75
- Golden-crowned sparrow.. 78
- Western chipping sparrow.. 80
- Western snowbird.. 82
- Western song sparrow.. 84
- Spotted towhee.. 86
- California towhee.. 89
- Black-headed grosbeak.. 93

ILLUSTRATIONS.

Page.
Plate I. California quail .... Frontispiece.
II. Arkansas kingbird 32
III. California jay 50
IV. Brewer blackbird 60
V. Bullock oriole 68
VI. Green-backed goldfinch 74

BIRDS OF CALIFORNIA IN RELATION TO THE FRUIT INDUSTRY—PART II.

INTRODUCTION.

The first part of the report on Birds of California in Relation to the Fruit Industry was published in 1907. In addition to the linnet or house finch, which has attracted wide attention and is the subject of much complaint, 37 other species were discussed. In the present and concluding part, the food habits of 32 additional species are treated. Among them are some of the most important birds of the State, regarded from the standpoint of the farmer and fruit grower. The aim has been to collect all data possible on the food of the several species, to consider the facts impartially, and to render a just verdict as to the birds' economic relations.

All the birds whose food habits are discussed have direct relations with husbandry. It is true that many of them have not been charged with the destruction or injury of fruit or any other farm products. Almost all, however, destroy great numbers of harmful insects or devour seeds of noxious weeds; hence they are important economically.

A large part of the present report consists of statements concerning the food actually found in the stomachs of the birds. In this connection it should be borne in mind that by far the greater number of stomachs used in this investigation were collected in the more thickly settled and highly cultivated parts of the State, so that they probably contain a larger proportion of the products of husbandry than would a series of stomachs taken at random from all parts of the range of each species. It goes without saying that fruit and grain can be eaten only by such birds as have access to those products, while birds living in uncultivated places must subsist upon the fruits of nature.

Some California birds show a marked preference for oats, but in this State the presence of oats in a bird's stomach does not necessarily indicate that cultivated oats have been eaten, for wild oats cover hundreds of thousands of acres, and in the cultivated areas grow almost everywhere, affording a supply of food for many birds. Besides wild oats, the crop of volunteer oats that succeeds the cultivated crop is abundant and is to be found wherever this grain is grown. In fact, in California the eating of oats can not as a rule be counted against a bird.

In no State in the Union is an accurate knowledge of the relations of birds to agriculture more important than in California. Climate and soil combine to make California an important grain and fruit producing State. The acreage already devoted to agriculture is large and is likely to increase for decades to come, as population increases and as new cultural methods are developed and irrigation is extended. Insects that now attract little attention are likely to increase and become serious pests. Certain birds formerly accustomed to a diet consisting partly of wild fruits, the supply of which is limited and likely to become smaller, will probably invade orchards and injure cultivated fruit. Hence it is worth while for the farmer and orchardist to learn as much as possible of the food of the birds that harbor near his premises, that he may know how much good each species does and how much harm, and so be enabled to strike a fair balance.

Some birds, like the swallows, swifts, wrens, and chickadees, are so strictly insectivorous that they are exceedingly beneficial. All they require at the hands of man in return for their services is protection. Others at some time of the year injure crops, though the damage by many is exceedingly small. Be the loss what it may, however, if a given species by its insectivorous habits prevents much greater destruction than it inflicts, the farmer should be willing to bear the loss for the sake of the greater gain.

Few birds are always and everywhere so seriously destructive that their extermination can be urged on sound economic principles. Only four of the species common in California can be regarded as of doubtful utility: These are the linnet, California jay, Steller jay, and redbreasted sapsucker. When the known methods of protecting fruit have been exhausted, or can not be employed profitably, then a reasonable reduction of the numbers of the offending birds is permissible. But the more the food habits of birds are studied the more evident is the fact that with a normal distribution of species and a fair supply of natural food, the damage to agricultural products by birds is small compared with the benefit.

A reasonable way of viewing the relation of birds to the farmer is to consider birds as servants, employed to destroy weeds and insects. In return for this service they should be protected, and such as need it should receive a fair equivalent in the shape of fruit and small grain. Nothing can be more certain than that, except in a few cases, any farmer who is willing to pay the toll collected by birds for actual services rendered will be vastly benefited. In the long run, no part of the capital invested in farm or orchard is more certain to pay big interest than the small sum required for the care and protection of birds.

CALIFORNIA QUAIL.

(*Lophortyx californicus* and *vallicola.*)

The California quail (see frontispiece) is common and generally distributed over the State west of the Sierra, except at the higher altitudes, and is especially abundant in the fruit-raising sections. Like the bobwhite of the East, this quail never goes far from cover, and it delights to dwell on unimproved land where trees and chaparral alternate with small areas of open ground. In settled regions it is somewhat domestic in habits and soon becomes accustomed to living in orchards, gardens, and cultivated grounds. The writer has seen a female sitting upon her eggs in a garden within 30 feet of a house, between which and the nest carriages and foot passengers passed many times each day. In winter a covey frequently feeds with the farmer's chickens, and if not disturbed will continue to do so until pairing time.

The natural food of the quail consists of the seeds of that vast group of plants known as weeds, with a little foliage of the same, especially in winter, when the leaves are young and tender. Considering how small is the amount of fruit usually found in the stomach of this bird, it is a surprise to learn that it sometimes does serious damage to vineyards. Investigation, however, shows that, as in most other similar cases, the injury results only when too many birds gather in a limited area. Nearly all the complaints against the quail for eating fruit are that it visits vineyards in immense numbers and eats grapes. When thousands visit a vineyard, even if only occasionally, and each bird eats or spoils at least one grape, the result is disastrous.

Mrs. Florence Merriam Bailey, writing of the foothills of San Diego County, says:

> In 1889 quail were so numerous that the dust of the roads was printed with their tracks, and it was an everyday matter to have them start out of the brush and run ahead of the horses quite unconcernedly, pattering along in their stiff, prim way, with their topknots thrown forward over their beaks. In fact, the quail were so abundant as to be a pest. For several years great flocks of them came down the canyons to Major Merriam's vineyard, where they destroyed annually from 20 to 30 tons of fruit. In one season, July to October, 1891, 130 dozen were trapped on his ranch. The result of this wholesale destruction was manifest when I returned to the valley in 1894. The birds were then rarely seen on the roads and seldom flushed in riding about the valley.[a]

Another observer states that he once saw a flock of about a thousand quail eating Zinfandel grapes in a vineyard in the central part of the State, and another says that in southern California he has seen as many as 5,000 feeding upon Muscat grapes. In the writer's interviews with California fruit growers, only one mentioned the quail as harmful. His ranch was situated along the hills on the side of a narrow valley, adjacent to wild grazing land with much chaparral and forest, among which the quail lived. In this case the annual loss was estimated at 2 or 3 tons of grapes.

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[a] Auk, XIII, p. 116, 1896.

In the laboratory investigation of the food of the California quail 619 stomachs were examined. They were collected in every month except May, but only one was obtained in March. The other months are well represented. Animal food, principally insects, amounts to but 3 percent, and most of this was found in the stomachs of young birds, mere broodlings. Vegetable food amounts to 97 percent and consists mainly of seeds of plants most of which are of noxious or troublesome species.

Animal food.—Ants appear to be a favorite food. They were found in 82 stomachs, and were eaten by adults as well as by young. They amount, however, to less than 1 percent of the whole diet. The rest of the animal food aggregates a little more than 2 percent and is distributed as follows: Beetles in 30 stomachs, bugs (Hemiptera) in 38, caterpillars in 11, grasshoppers in 7, flies in 2, spiders in 6, millepeds in 1, and snails in 2. The most interesting point in this connection was the stomach of a broodling only 3 or 4 days old. Besides several adult Hemiptera, some ants, caterpillars, and spiders, and a few seeds, it contained 280 minute insects, which constituted 76 percent of the stomach's contents, and were identified as an immature form of a species of scale, *Phenacoccus helianthi.*

In this connection the following extract from a letter dated at Los Angeles, Calif., October 28, 1908, by Dr. W. G. Chambers, to the Secretary of Agriculture is interesting:

> Last May during the hatching season one of my female quail died a week prior to completing the hatch. An incandescent light of 8 candlepower was substituted, the result being 15 baby quail, very wild at first, not understanding human sounds or language, but finally becoming as docile as pet chickens. They were raised in my back yard, running at large after the first week.
>
> A number of Marguerite bushes which grow in profusion in the yard were so infested with black scale that I had decided to uproot them and had postponed doing so, as the little quail worked so persistently among the branches; upon investigation I discovered them eating the scale and twittering happily; they would swallow the fully developed scale and thoroughly clean the branches of all those undeveloped.

The young in the first week of life eat animal matter to the extent of from 50 to 75 percent of the food, but by the time they are 4 weeks old they take little if any more animal food than the adults.

Vegetable food.—The vegetable part of the quail's food may be divided into fruit, grain, seeds, and forage. Fruit appeared in 106 stomachs, and aggregates 2.3 percent of the yearly diet. It was distributed as follows: Grapes in 7 stomachs, prunes in 9, apple in 3, Rubus (blackberry or raspberry) in 4, olive in 1, elderberry in 21, snowberry in 8, manzanita in 2, huckleberry in 11, and rose-haws in 3.

Pulp and skins, identified as fruit only, were found in 27 stomachs, and unknown seeds, probably those of some small fruit or berry, occurred in 10 stomachs. It is evident that the percentage of any one of the above is insignificant. Stomach examination throws no new light upon the quail's grape-eating habits, except to show that the ravages complained of are exceptional. That fruit does not constitute any important part of the bird's annual food is clearly proved.

Grain was found in 133 stomachs, and constitutes 6.4 percent of the food. It was distributed as follows: Corn in 14 stomachs, wheat in 15, oats in 13, barley in 89, and rye in 2. The principal complaints against the quail on the score of grain eating are that flocks sometimes visit newly sown fields, and eat large quantities of the seed. Walter E. Bryant says on this point:

> Two males which I shot one evening, as they were going to roost for the night, after having been feeding on a newly sown field, contained the following, mainly in the crop: (*a*) Two hundred and ten whole grains of barley, 6 pieces of broken barley, 3 grains of 'cheat,' and 1 of wheat, besides a few barley hulls, some clover leaves, and alfilaria; (*b*) one hundred and eighty-five whole grains of barley, 5 broken pieces, 4 grains of 'cheat,' and 2 of wheat; also barley hulls, clover, and alfilaria. The flock numbered nearly or quite 20 birds.[a]

Only one report accuses the bird of eating grain from the harvest field. Mr. W. T. Craig, of San Francisco, writing to the United States Department of Agriculture, says:

> I have observed the quail enter a field of wheat to the number of thousands, and had they not been driven away they would have destroyed the whole crop.

Stomach examination does not indicate any month in which grain is eaten in excess of other food. January shows the highest percentage, 12.4, but November is nearly as high, while December, although between the two, shows less than 3 percent. A little more than 3 percent was eaten in February, and none at all in March and April, though the newly sown grain would be accessible in one at least of these months. June and July, the harvest months, show respectively 4.1 percent and 10.7 percent. In fact the stomach record plainly indicates that the quail does not make special search for grain, but being naturally a seed eater takes grain when it comes in the way.

The seeds of a multitude of plants which have no apparent useful function except to increase by their decay the deposit of humus in the soil constitute the staff of life of the quail. In this particular investigation they aggregate 62.5 percent of the food of the year. They appear in stomachs taken in every month and reach a good percentage in each, the only months that show much diminution in quantity being January, February, March, and April, when new forage partly replaces seeds. The percentage is highest in June, 85.9, but shows no great falling off from July to December inclusive.

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[a] Zoe, IV, pp. 55–56, 1893–94.

Seventy-three kinds of seeds were identified, at least generically, and more than half of them were determined specifically. Many more were ground up so as to be unrecognizable. The following is a list of the seeds with the number of stomachs in which each kind occurred:

Poverty weed (*Iva axillaris*)	3
Gum weed (*Grindelia squarrosa*)	2
Bur marigold (*Bidens* sp.)	17
Sunflower (*Helianthus* sp.)	1
Tarweed (*Madia sativa*)	67
Mayweed (*Anthemis cotula*)	27
Milk thistle (*Silybum marianum*)	14
Thistle (*Cirsium* sp.)	5
Blessed thistle (*Cnicus benedictus*)	1
Bur thistle (*Centaurea melitensis*)	201
Sow thistle (*Sonchus asper*)	2
Sow thistle (*Sonchus oleraceus*)	1
Prickly lettuce (*Lactuca scariola*)	4
California dandelion (*Agoseris* sp.)	2
Blue vervain (*Verbena hastata*)	22
Stickseed (*Echinospermum* sp.)	16
Burweed (*Amsinckia tesselata*)	11
Ribwort (*Plantago lanceolata*)	2
Pursh ribwort (*Plantago purshi*)	1
Common plantain (*Plantago major*)	2
Painted cup (*Castilleia* sp.)	1
Black nightshade (*Solanum nigrum*)	10
Dodder (*Cuscuta* sp.)	3
Morning glory (*Convolvulus* sp.)	2
Pimpernel (*Anagallis* sp.)	2
Carrot (*Daucus carota*)	5
Lupine (*Lupinus* sp.)	150
Bur clover (*Medicago denticulata*)	156
Sweet clover (*Melilotus alba*)	6
Clover (*Trifolium* sp.)	75
Deer weed (*Lotus glaber*)	50
Vetch (*Vicia* sp.)	32
Five-finger (*Potentilla* sp.)	1
Turkey mullein (*Eremocarpus setigerus*)	168
Sumac (*Rhus laurina*)	69
Poison oak (*Rhus diversiloba*)	52
Alfilaria (*Erodium cicutarium*)	30
Alfilaria (*Erodium moschatum*)	
Carolina geranium (*Geranium carolinianum*)	47
Common geranium (*Geranium dissectum*)	
Wood sorrel (*Oxalis corniculata*)	1
Mallow (*Malva rotundifolia*)	11
Shepherd's purse (*Capsella bursapastoris*)	1
Peppergrass (*Lepidium* sp.)	5
Wild radish (*Raphanus sativus*)	5
Black mustard (*Brassica nigra*)	32
Wild turnip (*Brassica campestris*)	3
California poppy (*Eschscholtzia californica*)	1
Buttercup (*Ranunculus* sp.)	14

Water crowfoot (*Ranunculus aquatilis*)	3
Miner's lettuce (*Montia perfoliata*)	26
Red maids (*Calandrinia menziesi*)	58
Pigweed (*Chenopodium album*)	11
Rough pigweed (*Amaranthus retroflexus*)	77
Corn spurry (*Spergula arvensis*)	1
Common chickweed (*Stellaria media*)	62
Field chickweed (*Cerastium arvense*)	2
Sleepy catchfly (*Silene antirrhina*)	58
Black bindweed (*Polygonum convolvulus*)	1
Dotted smartweed (*Polygonum punctatum*)	2
Common knotweed (*Polygonum lapathifolium*)	2
Wire grass (*Polygonum aviculare*)	55
Curly dock (*Rumex crispus*)	9
Sorrel (*Rumex acetosella*)	59
Sedge (*Carex* sp.)	26
Galingale (*Cyperus* sp.)	7
Rag grass (*Lolium perenne*)	56
Soft brome (*Bromus hordeaceus*)	3
Cheat, or chess (*Bromus secalinus*)	18
Walk grass (*Poa annua*)	29
Timothy (*Phleum pratense*)	1
Bear grass (*Stipa setigera*)	5
Canary grass (*Phalaris caroliniana*)	2
Unidentified seeds, mostly ground up	293

From this list it would appear that bur thistle, lupines, bur clover, and turkey mullein are the favorite seeds; that the others are not distasteful is shown by the quantities found in some stomachs. For instance, mayweed was identified in only 27 stomachs, yet one stomach contained at least 2,000 of these seeds; pigweed (*Chenopodium*) in but 11, yet one contained 1,000. One stomach held 83 kernels of barley, 592 seeds of geranium, 560 of tarweed, 40 of bur thistle, 48 of clover, 80 of alfilaria, 704 of timothy, 32 of catchfly, and 5 of snowberry, or 2,144 seeds in all. Another contained 1,696 geranium seeds, 14 bur thistle, 24 knotweed, 14 tarweed, 38 bur clover, 148 alfilaria, 12 ray grass, and 1 unknown seed, and a pod of uncertain origin—in all 1,944 seeds and a pod. In both cases the contents of the crop is included with that of the stomach or gizzard. These samples indicate considerable variety in the quail's diet, even in one meal.

Grass and other forage constitute a little over 25 percent of the quail's annual food. Forage amounts to less than 1 percent in June, remains about the same until October, and increases somewhat in November. In January it becomes important, and it reaches nearly 60 percent of the food for the next four months. The maximum, 85 percent, occurs in March; but this percentage, based on only one stomach, can not be considered final. Seeds and forage are practically complementary to each other—that is, as one increases the other decreases. June, which shows the least forage, has the largest percentage of seeds. Leaves of red and of bur clover and of alfilaria were the favorite kinds, and in some cases constituted the whole stomach contents. Blades of grass are frequently taken. A few bits of acorn, and perhaps other nuts, were eaten, but the quantity is insignificant.

SUMMARY.

From the above analysis of the food of the California quail, it is apparent that under normal conditions the farmer and fruit grower have nothing to fear from its ravages. When, however, large areas of chaparral land are cleared and brought under cultivation, it is natural that the products of garden and vineyard should be eaten to a greater or less extent by quail, which abound in such localities. On the other hand, its seed-eating record is greatly in its favor. Usually there is little difficulty in getting rid of a superfluity of game birds; in fact, in most cases the trouble is to prevent their extermination. A bird so large, so easily trapped, so valuable as food, and withal one whose pursuit affords such excellent sport as the valley quail, will probably not become numerous enough to do serious damage except locally and under unusual conditions, and then a reduction of numbers is the easiest and simplest cure. Permits to trap quail on one's own premises are obtainable in California on application to the State fish commissioner. After the birds have been sufficiently reduced, they can be kept within reasonable limits by a moderate amount of shooting in the proper season.

WOODPECKER FAMILY.

(Picidæ.)

Among the useful birds of the State few take higher rank than the woodpeckers. They are mainly arboreal, and most of them may be designated as conservators of the forest in the strictest sense. The larvæ of certain species of beetles and moths live either under the bark or within the solid wood of trees, where they are safe from the attacks of birds, except such as are furnished by nature with special tools for digging into wood and bark. In this respect our native woodpeckers are in general highly favored. The peculiar structure of their chisel-shaped beak, combined with sharp claws and a stiffened tail for support, enables them, when they have located their prey, to drill down to it through several inches of wood and draw it forth with their tongue. This latter organ, in the more typical species of the family, is long, cylindrical, and barbed at the tip, being particularly well adapted for probing the burrows of boring insects.

Twenty-one species and subspecies of woodpeckers occur in California. Of these about half a dozen are sufficiently abundant and widely distributed to be economically important. The average amount of insect food in the stomachs of the six species discussed in the following pages is 62 percent of the whole contents.

It is unfortunate that the most valuable species of our woodpeckers are not abundant. In many parts of the country the downy and hairy woodpeckers are quite rare and, what is worse, appear to be diminishing in numbers. As they are among the most valuable of our species, it is worth while to inquire into the cause of their scarcity and if possible to devise efficient remedies. In most sections these birds can obtain an abundance of food, and as they are not persecuted, so far as known, the most probable cause for their scarcity would appear to be the lack of suitable nesting sites. This is especially true in the northeastern part of the United States where the war waged upon the gipsy and brown-tail moths has led to the trimming of all dead trunks and limbs from forests and orchards, so that the woodpeckers, which as a rule dig new nesting holes every year, are left with no places in which to nest. In Germany, after much experimentation, it has been found possible to construct nesting boxes which the European woodpeckers freely use. There can be no reasonable doubt that a similar result can be attained in this country. Pending experiments and as a step in the right direction, it would be well for orchardists to leave the stubs of dead limbs on orchard trees as sites for the nests of woodpeckers. While the woodpecker may use the nest it excavates only one season, the hole will be available for bluebirds, wrens, chickadees, and nuthatches in succeeding years. The experiment of inducing our woodpeckers, especially the downy and hairy, to build in artificially constructed nesting boxes is well worth patient and persistent experiment.

HAIRY WOODPECKER.

(*Dryobates villosus harrisi* and *hyloscopus.*)

Two subspecies of the hairy woodpecker occur in California, and between them they occupy nearly the whole State at some time of the year. Their favorite haunts are open groves and orchards, and as forests disappear and fruit trees increase in number, they will probably more and more inhabit orchards. That the hairy woodpecker is far from abundant at present is unfortunate, for its food habits make it of great economic importance. Only 27 stomachs have been examined, but the dates of collection are well distributed. Seven is the greatest number taken in any one month (September), and none at all were obtained in March, May, August, and October. While this number is sufficient to afford a general idea of the kind of food the bird prefers, it does not furnish reliable data as to the relative proportions of the different constituents.

Of the contents of the 27 stomachs, 78 percent consisted of animal matter, nearly all of which was either insects or spiders. The remaining 22 percent was made up of various vegetable substances. In the relative proportions of animal and vegetable food the California bird differs somewhat from the eastern subspecies, the diet of which consists of 68 percent of animal matter to 32 of vegetable.

Animal food.—Of the various items in the food of the western hairy woodpecker, the most important, as well as the largest, is the larvæ of wood-boring beetles (Cerambycidæ and Buprestidæ). These aggregate for the year nearly 49 percent of the total. This is a much greater proportion than is eaten by the eastern subspecies, and is probably not exceeded by any other bird. Each of several stomachs contained more than 20 larvæ. When the immense damage done by these borers to forest trees, as well as to orchards, is considered, it is hardly possible to overestimate the value of this woodpecker's services. Moreover, these insects are concealed and protected from the attacks of all birds except those of this family. Most of these insects are taken in the cooler months, the fewest being eaten in July. One stomach taken in February contained 70 percent of wood-borers, and the remainder, or 30 percent, consisted of other harmful beetles. Two stomachs taken in April contained an average of 76 percent of these destructive borers and 6 percent of other beetles. Beetles belonging to various families, nearly all of them harmful, and some very injurious, amount to over 9 percent of the food.

Ants are usually a favorite article of food with woodpeckers, but with the California hairy woodpeckers they constitute less than 3 percent of the year's food. This is somewhat surprising, as the eastern bird eats them to the extent of 17 percent. Other Hymenoptera, including wasps, amount to less than 2 percent.

Caterpillars exceed 11 percent, and stand next to beetles in importance. Many of them are of wood-boring species and evidently were dug out of trees.

A few miscellaneous insects and some spiders complete the animal food. Several stomachs contained segments of millepeds, or thousand legs, and one held the remains of one of those bristly creatures known as jointed spiders (Solpugidæ).

Vegetable food.—The vegetable part of the diet may be divided into fruit, seeds, and miscellaneous substances. Fruit amounts to 6 percent, and consists of the smaller kinds, probably mostly wild species. Rubus seeds (raspberry or blackberry), found in several stomachs, were the only fruits positively identified. Seeds aggregate nearly 12 percent, and all that were determined belonged to coniferous trees. The miscellaneous part contains a little mast and some cambium, or inner bark, but is mostly rubbish, such as rotten wood, probably swallowed accidentally with the beetle larvæ.

SUMMARY.

The above brief review of the food of the hairy woodpecker indicates that nearly half its yearly food consists of larvæ of some of the most destructive insects known, while this service is not offset by the destruction of any useful product. The other elements of the bird's food are either beneficial or neutral. It is unfortunate that the species is not more abundant on the Pacific coast.

DOWNY WOODPECKER.

(*Dryobates pubescens gairdneri* and other subspecies.)

To the ordinary observer the downy woodpecker is only a miniature edition of the hairy, which it resembles in everything but size. It seems, however, to be far more abundant than its larger relative, especially in California. It is much more domestic than the hairy, and frequents orchards and gardens and the vicinity of houses. Its food consists of the same elements but in different proportions. The following report is based on an examination of 80 stomachs, taken in every month of the year. The food consists of 77 percent of animal matter to 23 of vegetable, thus agreeing closely with the diet of the hairy.

Animal food.—The animal food is composed of insects, with a few spiders. The western downy eats 16 percent of wood-boring larvæ, a little more than the eastern downy, but less than one-third as much as the hairy woodpecker. Other beetles amount to 13 percent. They are mostly harmful species, the exception being a few Carabidæ, or predaceous ground beetles.

Ants are eaten to the extent of 12 percent, which is less than half the quantity taken by the eastern subspecies. While ants may sometimes subserve a useful purpose, they are for the most part annoying or noxious. It is well known that they protect and foster plant lice, and they often injure timber by boring galleries through it, frequently beginning in the abandoned burrow of a beetle larva. In houses they are an unmitigated nuisance, and in gardens and lawns are often equally obnoxious. For these reasons the habitual destruction of ants by woodpeckers is commendable. Other Hymenoptera amount to less than 2 percent, and consist of wasps and wild bees.

The largest item in the food of the downy is made up of caterpillars, pupæ, and a few adult moths. These aggregate a little over 21 percent. Pupæ of the codling moth were identified in 4 stomachs and the larvæ in 2, of which one contained 16 entire full-grown larvæ. Another held the remains of 20 of these pernicious insects. From investigations during the past few years it appears that birds constitute a most efficient natural check to the spread of this destructive moth, especially such birds as woodpeckers, titmice, nuthatches, and creepers, which obtain much of their food from crevices in the bark of trees. It behooves the orchardist to see that these birds are carefully protected on his premises and encouraged in every possible way.

The Hemiptera, or bugs, which appear in the food of the downy woodpecker are plant lice and scales, with a few other forms. They amount to 10 percent of the year's food, but all were eaten in the seven months beginning with March, and averaged 17 percent for each of these months. Scales were found in 8 stomachs, and in one they constituted 83 percent of the contents. The black olive scale (*Saissetia oleæ*) was the only one identified. Plant lice were found in 11 stomachs, but none were specifically identified, although some were of the woolly species. That these are a favorite food is shown by the quantity eaten. Five stomachs contained the following percentages: 94, 94, 84, 81, and 80. These creatures are so fragile that the process of digestion soon destroys their shape, and it is highly probable that small numbers were contained in many more stomachs but were not identified.

Grasshoppers, although a favorite article of bird food, are entirely ignored by the downy woodpecker. This emphasizes the arboreal habits of this species, as most birds feed upon grasshoppers, when in season, in preference to their ordinary food. Flies also are practically absent from the diet of the downy. A few miscellaneous insects and spiders, amounting in all to 3 percent, make up the remainder of the animal food.

Vegetable food.—The vegetable part of the food may be arranged under three heads—fruit, seeds, and miscellaneous items. Fruit was found in 14 stomachs, and amounts to 9 percent of the food. Cherries were identified in a few stomachs, and apples, or a similar fruit, in several more; but most of the remains were skins of small berries not further identified. Evidently this bird does little or no damage to fruit. Seeds amount to a little more than 7 percent, and are mostly those of poison oak, which the downy, in common with many other birds, aids in disseminating. Grain (oats) was found in 2 stomachs. The miscellaneous vegetable food, 7 percent, consists of mast, or acorn meat, a little cambium, and rubbish.

Food of young.—A nest of young downies was watched for 12 one-hour periods during six days, and the number of feedings noted as follows:

Date.	Hours in forenoon.	Number of feedings.	Hours in afternoon.	Number of feedings.
June 7	9.16–10.16	12	4.23–5.23	13
June 8	8.01– 9.01	10	1.13–2.13	10
June 9	10.42–11.42	12	5.00–6.00	10
June 10	9.17–10.17	14	2.34–3.34	10
June 11	10.15–11.15	11	4.49–5.49	15
June 12	10.37–11.37	20	4.33–5.33	23

In the twelve hours during which the birds were watched, the nestlings were fed 160 times, an average of 13⅓ times per hour; or each of the 4 was fed more than three times per hour. The nest was in a stub of a cherry tree in a mixed orchard, and apparently all the foraging was done in the immediate vicinity, as food was brought too often to have been carried any great distance; moreover, the parent birds were frequently seen searching the trees. Both parents took part in caring for the young, one often waiting patiently near by while the other fed the nestlings. At first the parent birds entered the nest chamber when they came with food, but later, as the nestlings grew larger, they remained outside, thrusting their heads in at the opening. The food nearly always appeared as a white mass in the beak, which led to the suspicion that the young were being fed with woolly aphids. The parent birds came from the direction of a number of apple trees which were badly infested with this pest, and the bark of the trees showed places from which the insects had been recently taken. Thus it was practically certain that aphids were being fed to the young woodpeckers.

SUMMARY.

From the foregoing account it is evident that the downy woodpecker is of great value to the horticulturist. Its food consists largely of orchard pests, and its levies upon fruit are insignificant. The orchardist should note that the downy makes its nest in a chamber which it excavates in a partly rotten trunk or limb of moderate size, frequently of an apple tree. Where such wood occurs in or about the orchard, it should be left for the convenience of the woodpecker and his successors, the wrens and titmice. By so simple a precaution as this the number of downies and of other useful birds that build in holes may be materially increased in an orchard and their services secured without cost at the very point where most needed. When trimming dead limbs, it is necessary only to leave a few inches of the stub, which is not unsightly, and which answers all the purposes of the woodpecker.

NUTTALL WOODPECKER.

(*Dryobates nuttalli.*)

The Nuttall woodpecker is well distributed over California west of the Sierra Nevada, but is less abundant than the downy and not quite so domestic. It is rather more fond of big oaks and other forest trees than of the orchard, but is often found on fruit trees.

The following analysis of its food is based upon the examination of the contents of 46 stomachs, taken in various parts of the State and in every month except May. The first division of the food into animal and vegetable matter gives 78 percent of the former to 22 percent of the latter, exactly the same as in the case of the hairy woodpecker.

Animal food.—Of the animal food, beetles are the largest item, and amount to nearly 34 percent. They consist largely of larval Cerambycidæ, or borers. While not so good a driller for insects as the hairy, the efforts of the Nuttall are not to be despised. It destroys a goodly number of wood-borers, but it eats more adult beetles of other families than do either of the species whose food has been discussed. A considerable number of small leaf beetles (Chrysomelidæ) are eaten by the Nuttall, and are probably taken from leaves. It eats also click beetles (Elateridæ), darkling beetles (Tenebrionidæ), and weevils (Rhyncophora), among which the genus *Balaninus*, that preys upon acorns and other nuts, was identified. A few predaceous ground beetles (Carabidæ) were found.

Ants do not appear to be a favorite food of this woodpecker, and they were eaten very irregularly. They constituted 36 percent of the food in June, 22 percent in September, and appear in small quantities in January and August, but are completely wanting in the other months. The average for the year is less than 6 percent. Other Hymenoptera form practically the same percentage, but nearly all were contained in a single stomach taken in December.

Hemiptera (bugs), like ants, are taken very irregularly and occur either in considerable quantities or not at all. In January they amount to 46 percent of the food of the month, in February to 28 percent, in June to 10 percent, in July to 36 percent, but in the other months do not appear. The average for the year is 11 percent. They belong to several families, but no special pest is prominent. Scales were found in two stomachs and plant lice in one. Three stomachs contained remains of the box-elder bug, *Leptocoris trivittatus*, of which two stomachs contained between 30 and 40 specimens each. This bug is very abundant in some places at times, and injures the box-elder tree. It has also done some damage to fruit.

Diptera (flies) were found only in the stomachs taken in June. They amounted to 12 percent for that month or 1 percent for the whole year.

Caterpillars stand next to beetles in the quantity eaten by the Nuttall woodpecker. They amount to over 13 percent of the food, and, except in the three winter months, appear very regularly. Many of them are of the wood-boring kinds, but leaf-eaters also are present. Various other insects, insects' eggs, and a few spiders amount to 7 percent, and complete the animal food.

Vegetable food.—Fruit amounts to 11 percent, or half of the vegetable food. Naturally most of it was taken during the summer and fall months, although the one stomach taken in December contained

35 percent of fruit pulp not further identified. The greater part of the fruit eaten is of wild species, of which the elder (*Sambucus*) is the favorite. Rubus fruits (raspberry or blackberry) were found in a few stomachs. Probably this bird will never do any serious harm by eating fruit. Seeds of poison oak, cambium, and mast (acorns) make up the other 11 percent of the vegetable food, and have no special economic interest, except that the scattering abroad of the seeds of poison oak is a nuisance. Taken as a whole, the vegetable food of the Nuttall is of little economic importance.

SUMMARY.

While the evidence at hand does not show that this bird feeds on any specific pest, yet it is doing good in preying upon noxious insects in general; moreover, it does not injure any product of husbandry. It should therefore be encouraged to pursue its good work.

RED-BREASTED SAPSUCKER.

(*Sphyrapicus ruber.*)

While the red-breasted sapsucker inhabits most of California at some time of the year, it is generally absent from the valleys during the warmer months, usually retiring to the mountains and forest regions to breed.

Of the 24 stomachs of this species received, nearly all were taken in fruit-growing sections, and represent only the months from September to March inclusive. Statements based upon the examination of so little material can scarcely be considered final, but considerable knowledge may be gained of the kinds of food eaten, even if the relative quantities can not be determined. The food consists of 63 percent of animal matter and 37 percent of vegetable.

Animal food.—Seventy-five percent of the animal food consists of ants, and the average per month is 40 percent of the whole diet. Two stomachs taken in January contained an average of 49 percent each. One stomach collected in March held 84 percent, and one in September was completely filled with them. In other months the amounts were less. In respect to ant eating this sapsucker keeps up the reputation of the family. Other Hymenoptera aggregate only a little more than 7 percent, and all were found in stomachs taken from October to December inclusive.

This bird, like its eastern relative, has the habit of removing patches of bark from certain live trees, usually willows, for the sake of cambium and of the sap which exudes; and it also eats the insects attracted by the sap, which are mostly bees, wasps, and ants; probably this accounts for the large predominance of Hymenoptera in the sapsucker's diet.

Beetles amounted in January to 3.5 percent, in November to 1.4 percent, in December to 0.7 percent, with none at all in the other months. The average for the whole year is only 0.8 percent. No larvæ of wood-borers were found, and apparently this bird never aids the hairy woodpecker in the good work of destroying these creatures. The species eaten were mostly small leaf beetles (Chrysomelidæ), with a few weevils.

Hemiptera (bugs) and Diptera (flies) were entirely wanting in the stomachs examined. Caterpillars were present in two stomachs, both taken in October. They amounted to 5 percent of the food of that month. One stomach taken in February was entirely filled by a large centipede.

Vegetable food.—The vegetable part of the food of the red-breasted sapsucker falls naturally into three divisions—fruit, seeds, and other vegetable matter. As the bird is not present in the fruit-growing sections of the State when fruit is ripe, it can not make great inroads upon the orchard. While fruit aggregates nearly 17 percent, it is mostly wild or of worthless varieties. Figs, whose seeds and pulp were found in one stomach, were the only cultivated kind identified. Several stomachs contained berries of the pepper tree (*Schinus molle*), one contained cascara berries (*Rhamnus californicus*), and in several were unidentified seeds and pulp. Seeds amount to about 9 percent, and are those of the poison oak, with a few others. The miscellaneous item is made up almost entirely of cambium, or the inner bark of trees, and amounts to about 11 percent of the whole food.

SUMMARY.

It is evident that the red-breasted sapsucker falls far below some other members of its family in economic importance. It does not prey upon the worst pests of the orchard and forest, but on the other hand it does not feed on the products of the orchard or farm. It injures trees by tapping holes in the bark and by stripping it off in patches, for which reason this sapsucker may be considered more harmful than beneficial.

CALIFORNIA WOODPECKER.

(*Melanerpes formicivorus bairdi.*)

The California woodpecker is distributed throughout a large part of the State, but is in the main confined to places where there is an abundance of large oaks—trees for which it appears to have a special liking and from which it derives much of its subsistence. Wherever it lives it is usually abundant and the most noticeable element of the bird fauna, attracting attention both by its loud cries and by its conspicuous flight. It is one of the few woodpeckers whose food is more largely vegetable than animal.

Of all the woodpeckers the California has made most impression on nonscientific observers, owing to its peculiar habit of drilling holes into the trunks and branches of dead trees or into the bark of living ones, in each of which it stores an acorn. Wherever the bird is abundant every dead trunk or large branch is punctured with holes, frequently less than an inch apart. So zealous is it in this work that when trees are not available it often drills holes in cornices, church spires, telegraph and telephone poles, and fence posts. The woodpecker does not get the benefit of all its hoarded acorns by any means, for jays, rats, mice, and squirrels have learned where they can obtain food in winter, and are not backward in helping themselves to the woodpecker's stores. As this robbery of his larder is resented by the owner, it leads to endless quarrels.

For the laboratory investigation of the food of the California woodpecker 75 stomachs were available. They were taken in every month except February, April, and May, the greater number in June and July, when the bird's chances to do mischief are greatest. The food consists of 22.43 percent of animal matter to 77.57 percent of vegetable. This is the highest percentage of vegetable matter yet found in the stomach of any woodpecker, though the red-bellied (*Centurus carolinus*) comes very close to it.

Animal food.—Beetles constitute the smallest item of the animal food. They amount to less than 3 percent, and are distributed among several families. The only month in which they are at all prominent is July, when they reach nearly 15 percent. No wood-boring larvæ were found. This would seem to indicate that the bird uses its chisel-shaped bill solely for the purpose of boring holes in which to store acorns, instead of excavating for insects.

Ants amount to 8.21 percent of the food. In one stomach taken in March they constitute 50 percent of the contents, but in no other do they reach 11 percent. The specific name of this bird, *formicivorus*, ant-eating, is not well chosen, for ants do not form a large part of its diet as compared with several other woodpeckers. Other Hymenoptera amount to 6.88 percent. More than half of these were in stomachs taken in August, when they aggregate 33 percent.

A few bugs, flies, and grasshoppers, with fragments of caterpillars, make up the remainder of the animal food, 4.52 percent. One stomach contained a few black olive scales.

Vegetable food.—Grain, fruit, and mast constitute nearly the whole of the vegetable food. One stomach taken in January contained nothing but corn, and another in December contained a few corn hulls. This is the whole of the grain record, and is of no economic interest. The average for the year but slightly exceeds 1 percent. Fruit amounts to a little more than 24 percent, and was found in nearly every month in which stomachs were taken. Most of it was evidently the pulp of the larger cultivated varieties, though that in the stomachs taken in winter could have had no economic value. Seeds of the elderberry (*Sambucus*) were found in two stomachs. The largest amounts of fruit were eaten in August and September, when they reached 59.34 and 54 percent, respectively. While this is a high percentage of fruit, it is not believed that the bird does any sensible damage in the orchard, since it is not numerous enough and does not usually frequent cultivated ground. No complaints of such damage have yet been heard.

The principal item of food of the California woodpecker is acorns. Acorns form 52.45 percent of the year's food, and were found in every month when stomachs were taken except August; as only three were collected in that month, the record is not very reliable. In November, when 12 stomachs were taken, mast amounted to nearly 93.58 percent of the average contents. In 12 stomachs collected in June, when fruit and insects are abundant, it averaged 79.25 percent. In July it fell to 29.47 percent, the deficiency of acorns being made up by animal food, which attains the highest percentage in that month. The question has been raised whether the woodpecker stores acorns for the sake of the meat, or for the grubs that frequently develop therein. Stomach examination shows that, while the substance of the acorn is eaten freely whenever obtainable, larvæ are almost entirely wanting. It is therefore the nuts themselves that the woodpecker stores for food. From an economic point of view little objection to this acorn-eating habit can be raised. The acorn crop is usually superabundant, and in most cases can not be put to better use than to tide the woodpeckers over the winter until insects become plentiful.

SUMMARY.

From the foregoing discussion of the food of the California woodpecker it is obvious that the bird's food does not possess high economic value. On the other hand the bird can not be charged with the destruction of useful insects or of any product of husbandry. While it eats some fruit, it does not habitually infest orchards, and is seldom numerous enough to be a serious nuisance. The few insects it eats are nearly all harmful.

The trees used by the bird for storehouses are usually dead or partly so, and in living trees the punctures do not go through the bark, so that no harm is done. When holes are drilled in buildings, fences, or telegraph poles, the injury is real, but on the whole the damage done in this way is not extensive.

When the beneficial and injurious habits of the bird are carefully weighed, the balance is decidedly in the bird's favor; and from the esthetic standpoint few birds are more interesting and beautiful.

RED-SHAFTED FLICKER.

(*Colaptes cafer collaris.*)

In food habits the flickers of California do not differ essentially from their eastern relatives. They are usually abundant wherever there are trees, and are frequenters of orchards, though they usually choose higher trees for nesting sites. They are among the most terrestrial of the woodpeckers, and obtain a large part of their food on the ground.

For the investigation of the flicker's food 118 stomachs, taken in all months except January and May, were available. In these stomachs animal food amounts to 54 percent and vegetable to 46 percent.

Animal food.—Beetles, in either adult or larval form, do not appear to be favorite food with the flicker. They amount to 3 percent of its diet, and are apparently eaten to a small extent in every month. In August they amount to 8 percent, in November to 7, and in all other months the percentage is small. They belong to 6 families, all harmful except the predaceous ground beetles (Carabidæ). These occurred in 33 stomachs, but the percentage in each case was small, and they seem to be taken only incidentally. Weevils were found in 4 stomachs, click beetles in one, darkling beetles in 6, rove beetles in 3, and *Notoxus alamedæ* in one.

Ants constitute the largest item of the flicker's food, and are eaten in every month. They are the object of the bird's search on the ground and in rotten logs and stumps. The average for the year is 45 percent, the same as was found in 230 stomachs of the eastern flicker. The stomach and crop of one individual of the eastern form taken in Texas was filled with over 5,000 small black ants (*Cremastogaster*). Each of several California stomachs held more than 1,000 of these insects, and others but few less. In 10 stomachs taken in June the average percentage of ants was 76; in 10 taken in July, it was 87 percent. November was the month of least consumption, when the average of 34 stomachs was 7 percent. Of the 118 stomachs, 78, or 66 percent of the whole, contained ants, and 14 held nothing else, except a little rubbish in three, and in one a few seeds of filaree (*Erodium*). Inasmuch as certain ants in California, in the latter part of summer, make a business of harvesting seeds, probably this particular woodpecker had picked up a few ants that were thus employed. Hymenoptera other than ants are eaten by the flicker only occasionally, and average less than 1 percent of the yearly food.

Miscellaneous insects amount to nearly 5 percent. They consist of common crickets, wood crickets, mole crickets, caterpillars, white ants (*Termes*), spiders, and sow bugs (*Oniscus*). All of these suggest decaying logs and stumps, where the flicker obtains a large share of its food.

The following insects and crustaceans were identified in the food of the flicker:

COLEOPTERA.

Amara insignis.
Anisodactylus dilatatus.
Anisodactylus piceus.
Calathus ruficollis.
Platynus maculicollis.
Harpalus sp.

HYMENOPTERA.

Formica neorufibarbis.
Cremastogaster lineata.
Lasius sp.
Messor andrei.
Solenopsis geminata.
Prenolepis imparis.

CRUSTACEA.

Porcellio scabra.
Oniscus sp.

Vegetable food.—The vegetable food of the flicker includes many items. They may, however, be grouped under four heads: Mast, grain, fruit, and other vegetable food. Mast forms 10 percent of the food. It is taken fairly regularly, but in the greatest quantity in winter. It was contained in 15 stomachs, 1 holding nothing else. In one case it was English walnut, but in all others it appeared to be the meat of acorns. December showed the maximum amount, 40 percent. Grain was found only in stomachs taken in August, October, and November, the highest percentage being in August, about 17 percent. The total for the year was only 4 percent. It was all contained in 16 stomachs, and consisted of corn in 14 cases, barley in 1, and oats in 1. A stomach taken in November was entirely filled with corn. It is not likely, however, that the flicker ever does serious damage to corn or any other grain. The examinations do not indicate any great fondness for this food, and observation has never shown that the bird makes a practice of visiting grain fields.

Fruit was found in 39 stomachs, in 26 of which it was thought to be of cultivated varieties, but in the other 13 it was wild. Apples, cherries, grapes, prunes, and probably pears were the domestic fruits identified. One stomach was entirely filled with apple pulp and another practically so. Grapes are apparently the favorites. The wild varieties of fruit identified were pepper berries, elderberries, and gooseberries. Fruit pulp that could not be further determined was found in several stomachs and was classified as domestic, although it may have been wild. The aggregate of fruit for the year is 15 percent. While no complaints have been lodged against the flicker for depredations upon fruit, evidently it can do serious damage where it is abundant. It enjoys living in orchards or their immediate vicinity, and, as the stomachs show, does not hesitate to sample their products, but it eats most of its fruit in the latter part of the season, after cherries, apricots, peaches, and prunes have been gathered. September is the month of greatest consumption, 48 percent. Fruit is taken quite regularly during the rest of the year; but only 6 percent was eaten in June, the month of cherries, and 7 percent in July, the month when apricots are at their best, and none in August, the month of peaches and prunes. The damage done to fruit by the flicker probably consists in spoiling a few choice specimens, rather than in extensive destruction of the crop.

Various other substances make up the remaining vegetable food of the flicker, 17 per cent. Of these the most conspicuous is the seed of poison oak (*Rhus diversiloba*). These noxious seeds were found in 41 stomachs, and 1 was entirely filled with them. Very few are eaten in June and July, but they form an important article of diet through the fall and winter. The month of greatest consumption is October, when they constitute 40 per cent of the total food. The consumption of these seeds would be a decided benefit to man if they were ground up and destroyed in the stomachs. Unfortunately they are either regurgitated or pass through the intestinal tract uninjured and ready to germinate. The action of the stomach simply removes the outer covering, a white, wax-like substance, which is probably very nutritious, and is evidently relished by many birds. Birds are probably the most active agents in the dissemination of these noxious shrubs. On the other hand, these seeds, which are wonderfully abundant, afford food for thousands of birds during the winter, when other food is hard to obtain, and thus enable the birds to tide over the cold season to do their good work of destroying insects the next summer. Seeds of a nonpoisonous Rhus, some weed seeds, and a little rubbish were found in a few stomachs.

The flicker of California, and probably of the west coast in general, has one habit not observed in the eastern species. The mild climate and abundant food supply render migration unnecessary, but, like many other birds that nest in holes in trees, it likes shelter during the winter nights. As trees in which cavities can be made are not numerous enough, it pecks holes in buildings, as barns, schoolhouses, and churches. It often happens that the hole leads into the interior of the building and so proves useless to the bird, and it makes another and another till it hits the right place—in the cornice, for instance. Usually several holes are made before suitable shelter is found, and the consequent disfigurement and damage are sometimes serious.

SUMMARY.

In summing up the food of this flicker, two points are important—the destruction of ants and the eating and consequent scattering of the seeds of poison oak. The destruction of ants is a benefit, but it does not appeal to the horticulturist and farmer as does the destruction of well-known pests. While people are often annoyed by ants, they seldom suffer much damage by them. However, though ants do not destroy fruit or other crops to any great extent, they aid and abet other insects which do considerable harm. This is particularly true in regard to plant lice, which are housed, protected, and generally cared for by ants. Ants also continue the destructive work in timber begun by beetle larvæ until the wood is rendered worthless. The other insects eaten by the flicker are all more or less harmful, except a few useful ground beetles (Carabidæ). Most of the vegetable food is neutral; the amount of fruit and grain destroyed is not sufficient to constitute serious injury, but the scattering broadcast of the seeds of poison oak is harmful. As on the whole the flicker does more good than harm, it should be protected and encouraged.

OTHER WOODPECKERS.

Several other species of woodpeckers inhabit the State of California but, excepting the Lewis woodpecker, they are neither so numerous nor so generally distributed as those already treated. Their food consists in the main of the same elements, although the proportions vary with the species. The Lewis woodpecker (*Asyndesmus lewisi*) is perhaps the most important of these species, but since only 23 of its stomachs are available for examination, a definite statement of its food during the year can not yet be made. It appears to eat rather more vegetable than animal food, and in fall and winter eats large quantities of acorns. In the selection of its animal food it resembles the flicker in showing a decided taste for ants and other Hymenoptera.

Dr. C. Hart Merriam contributes the following note on this species:

> The Lewis woodpecker is one of the commonest and most widely distributed woodpeckers of California, in these respects coming next after the California woodpecker (*Melanerpes formicivorus bairdi*). But owing to its habit of breeding at higher altitudes it is less often seen in the lower and more highly cultivated parts of the State, except during migration. It breeds mainly in the Ponderosa pine forests of the mountains (Transition zone), whence, usually in early September, it descends into the blue oak and Digger pine belt of the foothills to spend the winter.
>
> Like the California woodpecker, it is a skillful flycatcher, pursuing and capturing insects in mid-air. But in fall and winter its principal food is acorns, of which it eats surprising quantities. At this season is is usually seen in small flocks of from 6 to 20 birds, each carrying a large acorn in its bill.
>
> These woodpeckers are very fond of ripening apples, and in early September descend in flocks upon the orchards, particularly those of the higher foothills, and in certain cases, if let alone, destroy practically all the fruit. I have heard of their depredations in various parts of the State and have personally seen the birds, in early September, circling about the orchards and diving down into the apple trees between Round Mountain and Montgomery Creek, and in Fall River Valley, Shasta County, and in Scott Valley and the upper canyon of Klamath River near Beswick, in Siskiyou County. At the latter place they are so destructive that during the ripening of the fruit gunners employed to shoot them frequently kill 25 in a day, and in early September, 1907, I was told that as many as 50 had been killed in one day.

While, as stated above, our investigations have not proceeded far enough to enable a final statement to be made regarding this woodpecker's economic status, enough is known to justify the belief that the bird, by its destruction of insects the year round, is much more beneficial than injurious, despite its occasional depredations on apples and other fruit.

The sapsuckers of the genus *Sphyrapicus* have been accused of doing much harm by boring into fruit and other trees for sap, and while the charge is well founded the injury is largely counterbalanced by the bird's destruction of insects. The sapsuckers are not numerous enough, however, to be reckoned an important factor either way.

FLYCATCHER FAMILY.

(Tyrannidæ.)

Among our useful birds the flycatchers (Tyrannidæ) take high rank. As is well known their principal food consists of insects captured in mid-air. If the name flycatcher implied that these birds subsisted largely upon flies (Diptera), it would be a misnomer, for nearly all the species eat far more Hymenoptera than Diptera. In fact waspcatcher would be much more appropriate. The name, however, is intended to suggest the idea that the birds are flying when they catch their prey. The capture of food in this way implies that the species are strong, rapid flyers, and capable of making quick turns in the air. In addition to flying insects, the flycatchers eat spiders and other wingless forms and some vegetable food which they pick up from the ground or snatch from trees. The animal food of the 6 species discussed in the following pages averages 90 percent of their diet.

Several flycatchers in the eastern part of the country are quite domestic in their habits and frequent orchards and gardens, and some species nest about buildings. In California some of the corresponding species have not yet become so accustomed to the presence of man and his works, but they are learning rapidly. The black phoebe is perhaps as familiar there as is the common phoebe in the East; but the kingbird of California has not fully decided that the orchard is a safe and altogether desirable place for nesting purposes. Sixteen species and subspecies of flycatchers have been found within the limits of this State. Six of them are numerous enough to be of economic importance.

ASH-THROATED FLYCATCHER.

(*Myiarchus cinerascens.*)

The ash-throated flycatcher is a summer resident of the lower and warmer parts of the State. Its habit of nesting in cavities perhaps causes it to seek the vicinity of farm buildings, where such accommodations are numerous. It builds in hollow trees also, which may often be found in the older orchards. The eastern species (*M. crinitus*), which nests in hollow trees, habitually places the shed skin of a snake in the walls of its nest. The reason for this is not plain, but the writer has never seen or heard of a nest in which the snake skin was lacking. The ash-throat occasionally does the same thing, but apparently does not consider the snake skin indispensable. Though an orchard bird, it seldom eats any cultivated fruit, but confines its diet largely to insects, most of which are either injurious or neutral.

In the following investigation of the ash-throat, 80 stomachs were used, collected from April to December inclusive, but only one in each month after July. Animal food amounts to 92 percent and vegetable to 8 percent for the season. Stomachs taken in April, May, August, October, and November contained no vegetable food whatever. The one stomach taken in September held 44 percent of elderberries, which is exceptional. A greater number of stomachs in this month would probably have reduced this percentage considerably.

Animal food.—Of the animal food, beetles, almost entirely of harmful species, amount to 5 percent. The two families most prominent in the food are the longicorns (Cerambycidæ) and the metallic woodborers (Buprestidæ), which are the very ones whose larvæ are so extensively eaten by woodpeckers. Next to these were the click beetles (Elateridæ), that bore into various plants and do much damage, and a few weevils or snout beetles (Rhynchophora). A ground beetle (Carabidæ) was found in one stomach, and a ladybird (Coccinellidæ) in another, these being the only useful beetles taken.

Bees, wasps, and a few ants (Hymenoptera) amount to 27 percent. They are eaten regularly in every month when the bird is on its summer range. Five stomachs were taken in the vicinity of an apiary, but not one of them contained a trace of a honey bee, though one bird had eaten 24 percent of robber flies (Asilidæ), which have been known to prey upon bees.

Bugs (Hemiptera) aggregate about 20 percent of the food of the ash-throat, which is the largest showing for that order of insects yet found in the food of any flycatcher. They were all eaten in the months from May to August inclusive, and form a good percentage in each of those months. They belong to the families of stinkbugs (Pentatomidæ), shield bugs (Scutelleridæ), leafhoppers (Jassidæ), jumping plant lice (Psyllidæ), common plant lice (Aphididæ), tree hoppers (Membracidæ), cicadas (Cicadidæ), and assassin bugs (Reduviidæ). The last is a family of predaceous insects which are useful, as they destroy some harmful insects, but all the others are injurious, and some are pests. While many of these are taken upon the wing, probably some are picked from plants. One bird was seen on a mustard plant feeding upon the plant lice, which completely infested the plant. One stomach was entirely filled with tree hoppers and two with cicadas.

Flies (Diptera) amount to about 14 percent and were eaten in nearly every month. Robber flies were identified in two stomachs, one of which has already been referred to. Most of the others were of the family of the common house fly (Muscidæ).

Caterpillars were found in 20 stomachs and moths in 7. Together they amount to 19 percent of the food. This shows that caterpillars are a favorite article of food with this bird, and proves that it does not take all its food on the wing. While no stomach was entirely filled with caterpillars, one contained nothing but moths.

Grasshoppers formed about 5 percent of the food, and were mostly taken in May, June, and July. One stomach contained nothing else. As they do not often come within reach of flycatchers, these insects must be especially sought for.

Various other insects and spiders amount to a little more than 3 percent. Among these the two most prominent were dragonflies and Raphidia. These last are small insects with remarkably long necks, and as they prey upon other insects and are said to feed upon the larvæ of the codling moth, their destruction by birds is to be deplored. Spiders are eaten by the ash-throat quite regularly, but not extensively. Apparently, most birds take spiders when found, but do not seek for them.

Vegetable food.—Vegetable food was found in 9 stomachs. Of these, 5 contained remains of elderberries; 2, bits of other small fruit; and 2, skins which might have been those of cultivated varieties. The total for the year is 8 percent.

Feeding of young.—Besides the examination of stomachs of the ash-throated flycatcher, observations were made upon the feeding of a nest of young situated in the cornice of an abandoned ranch house. The nest contained four young about a week old when first discovered. The number of feedings and times of observations are given in the following table:

Date.	Hours in forenoon.	Number of feedings.	Hours in afternoon.	Number of feedings.
June 18			12.59–1.59	9
June 22	10.48–11.48	14	2.07–3.07	9
June 26			2.13–3.13	18
Do			5.56–6.26 (half-hour.)	6
June 27	5.15– 6.15	28		
Do	11.27–12.27	9	4.47–5.47	9
June 28	5.26– 6.26	16		

In all, the nest was observed for eight and one-half hours and 119 feedings were noted, or an average of 14 feedings per hour. Both parent birds took part in the feeding until the female was unfortunately killed after the first hour of feeding on the morning of June 27. It will be noted that during this early hour more feedings were observed than at any other, and that at practically the same hour the next morning, June 28, the male bird alone was able to feed only 16 times. However, the young did well, and left the nest that afternoon. As the day was about fourteen hours long when the above notes were taken, each of the young birds must have been fed about 49 times every day, or 196 insects in all. It is safe to say that the parents would eat enough more to bring the total up to 250. Several nests of this bird in an orchard would make quite a difference in the number of insects surviving to propagate the next year's supply.

SUMMARY.

From the foregoing it is evident that the ash-throat attacks no product of husbandry, but keeps up an incessant war upon insects. Of these it devours a vast number in the course of the year, mostly harmful species. This bird likes to reside in the vicinity of houses, gardens, and orchards. Let it be encouraged by all means.

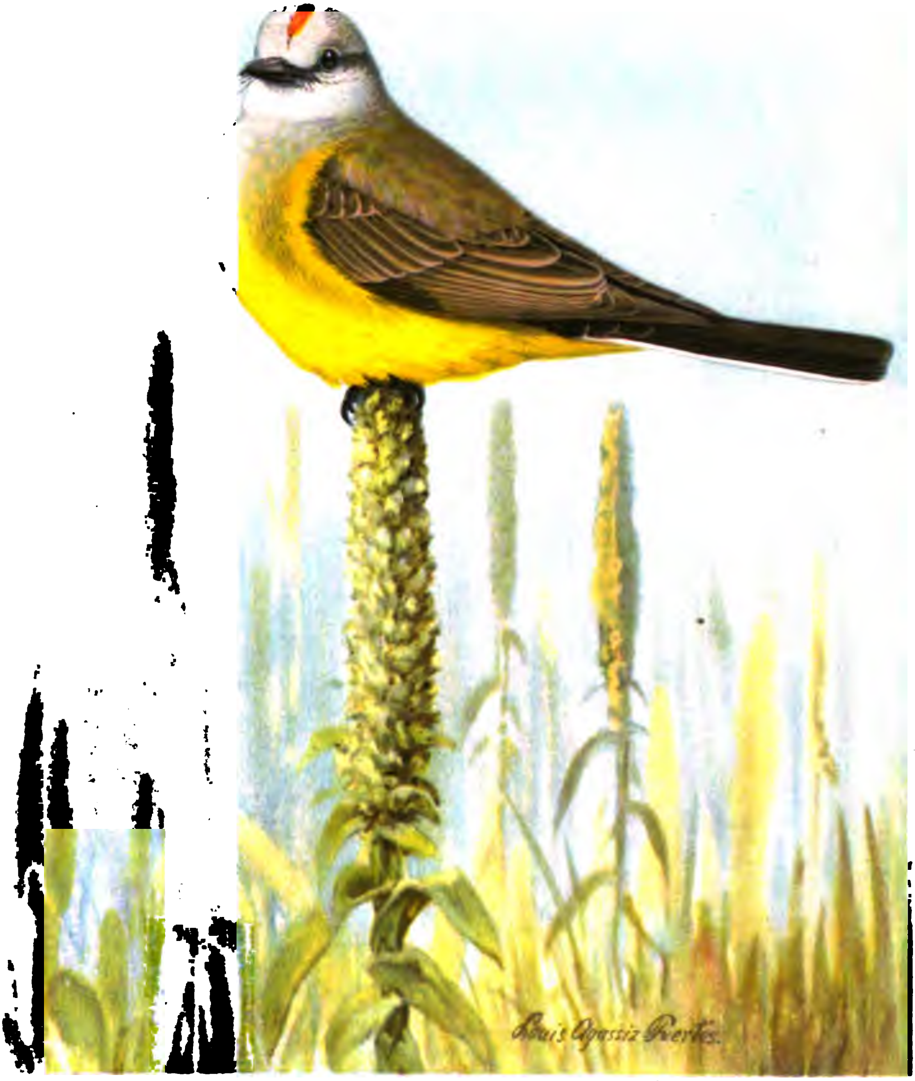
ARKANSAS KINGBIRD.

(*Tyrannus verticalis.*)

The Arkansas kingbird (Pl. II) inhabits the lower and warmer part of the State, mainly as a summer resident. It is not so domestic as its eastern relative, the common kingbird, and seems to prefer the hill country, with scattering oaks, rather than the orchard or the vicinity of towns or ranch buildings.

For the investigation of the kingbird's food 78 stomachs were available. Most of them were taken from March to July inclusive, but a few in September, October, and December. The bird's yearly food is made up of 87 percent of animal matter to 13 percent of vegetable.

Animal food.—The animal food is composed of insects and a few bones of a batrachian (tree frog or salamander). Both the eastern and western kingbirds have been accused of destroying honey bees (*Apis mellifera*) to a harmful extent. It is said that the birds linger about the hives and snap up the bees as they return home laden with honey. Remains of honey bees were searched for with special care, and were found to constitute 5 percent of the food. Thirty-one individuals were discovered in 5 stomachs. Of these, 29 were drones, or males, and 2 were workers. In 3 stomachs containing males there was no other food, and when it is borne in mind that there are thou-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ARKANSAS KINGBIRD

sands of worker bees to one drone, it appears that the latter must be carefully selected. As a rule, the destruction of drones is not an injury to the colony, and often is a positive benefit. The food of the eastern kingbird shows practically the same ratio between drones and workers. Hymenoptera other than honey bees amount to 38 percent, and include wild bees, wasps, and ants, with a few parasitic species. The latter are very useful insects, and their destruction is an injury, but fortunately the kingbird is not especially fond of them.

The late Walter Bryant, of Santa Rosa, Calif., says:

> Mr. A. Barnett, of San Diego County, had 300 swarms of bees, which attracted the flycatchers to such an extent that he made some investigations to ascertain to what extent they might be damaging the bee industry.
>
> Over 100 flycatchers were dissected, principally Arkansas flycatchers and phoebes (Black and Say's?). In all of the Arkansas flycatchers drones were found, but no working bees, although in many cases the birds were gorged. In most of the phoebes drone bees were found; the only exception was that of a phoebe (Say's?) in which a bee's sting was found in the base of the tongue.
>
> The birds were all shot about apiaries and were seen darting upon and catching the bees.[a]

Such testimony is sufficient to clear these flycatchers of the suspicion that they interfere with the bee industry.

Beetles of various families form about 14 percent of the food. They are all harmful species except a few predaceous ground beetles and ladybird beetles. They were taken very regularly through the months, and appear to be a favorite food.

Orthoptera—grasshoppers and crickets—amount to 20 percent. They were taken pretty regularly through all the months. Even the 3 stomachs secured in December show an average of 44 percent. Probably few of these were caught on the wing, and their abundance in the food indicates that this bird, like many others, forsakes its usual style of feeding and goes to the ground to catch grasshoppers whenever they are numerous. Two stomachs were entirely filled with these insects, and in several others they amounted to over 90 percent of the contents.

Miscellaneous insects, consisting of caterpillars and moths, a few bugs, flies, and a dragonfly, constituted 10 percent. Several stomachs contained a number of moths, and one was entirely filled with them. Not many birds eat these insects extensively in the adult form, while the larvæ (caterpillars) are a prominent feature of the diet of most insectivorous birds. Besides insects, bones of some batrachian, probably a tree frog, were found in three stomachs and an eggshell in one. They amount to only a trifling percentage. Frogs or salamanders seem queer food for a flycatcher, but their bones have been found in the stomachs of several species of tree-haunting insectivorous birds.

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[a] Zoe, IV, pp. 57–58, 1893.

The following is a list of insects identified in the stomach of the Arkansas kingbird:

COLEOPTERA.

Platynus sp.
Aphodius fimetarius.
Amphicoma ursina.
Cremastochilus sp.
Geotrupes sp.
Megapenthes turbulentus.
Epicauta sp.
Hydaticus stagnalis.
Agabus sp.
Silpha ramosa.
Staphylinus luteipes.
Balaninus sp.

HYMENOPTERA.

Apis mellifera.
Prosopis affinis
Habropoda sp.
Melissodes sp.
Andrena sp.
Cryptus sp.
Ophion bilineata.

HEMIPTERA.

Euschistus servus.
Nezara sp.
Podisus modestus.
Calocoris rapidus.
Eurygaster alternatus.

Vegetable food.—The vegetable food of the Arkansas kingbird amounts to about 13 percent, and consists mostly of fruit. It was all contained in 15 stomachs, of which 10 held elderberries (*Sambucus*) and 5 various small berries not positively identified. One also contained an olive, the only cultivated fruit found. A few seeds also were noted.

SUMMARY.

In a summary of the economic significance of the food of this kingbird it should be noted that the bird must be judged by its destruction of insects, for, since it does not eat any product of cultivation to an appreciable extent, its vegetable food can be disregarded. The offense of eating honey bees, so long laid at this bird's door, is practically disproved, for the more or less useless drones eaten far outnumber the useful workers. The injury the kingbird does, if any, is by eating predaceous beetles and parasitic Hymenoptera, but it takes these in such small numbers as to leave no reasonable doubt that the bird is one of our most useful species.

CASSIN KINGBIRD.

One other species of *Tyrannus* (*T. vociferans*), commonly known as the Cassin kingbird, occurs in the southern half of the State, where it frequents orchards and ranches. It is less abundant than the Arkansas kingbird, but has similar habits, and an examination of several stomachs shows that the food of the two species is practically the same.

SAY PHOEBE.

(*Sayornis saya.*)

While the Say phoebe inhabits California throughout the year, it is locally wanting in summer in many places west of the Sierra. In the fruit-growing regions visited, the writer met with only one individual during the spring and summer months, but these phoebes became fairly numerous in September, and increased in numbers as the season advanced. The investigation of their food was based upon the examination of 86 stomachs, taken in every month from September to March inclusive, and 2 taken in June. This bird was shown to be one of the most exclusively insectivorous of the family, although no stomachs were available for the months when insects were most numerous. The food consists of 98 percent of animal matter and 2 percent of vegetable.

Animal food.—As a number of predaceous ground beetles (Carabidæ) were in these stomachs, a separate account was kept of them. They amount to somewhat over 5 percent, and are pretty evenly distributed through the months, except February, in which 25 percent were eaten. These were in one stomach, which they half filled, and as only 2 stomachs were taken in that month, the percentage was probably made too great. It seems impossible that all these beetles, which are rather averse to flying, could have been caught on the wing, especially since none were taken in the warmer months, when they are most active. In the other beetle food, which amounts to 10 percent, a few ladybirds (Coccinellidæ) were found. These and the ground beetles must be recorded against the bird, but the fault is not serious. The remainder of the beetles were all of injurious or neutral species.

Hymenoptera, including quite a number of ants, amount to 35 percent, and were contained in 69 stomachs, or over 78 percent of the whole. This illustrates the statement that these birds are wasp-catchers rather than flycatchers. A few parasitic species were among the rest. Bugs, as is so often the case, were eaten quite regularly, but in rather small quantities. They amount to about 5 percent of the food, and belong to the following families: Stinkbugs (Pentatomidæ), the squash-bug family (Coreidæ), leaf bugs (Capsidæ), negro bugs (Corimelænidæ), leafhoppers (Jassidæ), tree hoppers (Membracidæ), and assassin bugs (Reduviidæ). These last are reckoned as useful insects, but they were identified in only one stomach.

Flies (Diptera) aggregate 10 percent of the food, and were eaten mostly in the months of January, March, and November; but probably this is accidental and would not hold true with a greater number of stomachs. The only family identified was that of the common house fly (Muscidæ). One stomach was entirely filled with them. Moths and caterpillars (Lepidoptera) appeared in 27 stomachs, and amount to something more than 10 percent of the food. Moths were found in 15 stomachs and caterpillars in 12. This is contrary to the usual rule that in this order of insects the larvæ are eaten by birds much more freely than are the adults.

Grasshoppers and crickets (Orthoptera) are eaten by the Say phoebe to the extent of 14 percent, which is the highest record of any flycatcher except the Arkansas kingbird. These, taken in connection with the ground beetles, ants, and caterpillars, indicate a somewhat terrestrial habit of feeding. Nearly 40 percent of the grasshoppers consumed were taken in September, after which they steadily decreased in quantity. One stomach was entirely filled with them.

Miscellaneous insects, spiders, and a few other creatures make up the rest of the animal food, about 8 percent. Of these, spiders were found in 10 stomachs, dragonflies in 5, sowbugs (*Oniscus*) in 1, and another unidentified crustacean in 1.

Vegetable food.—The vegetable food of the Say phoebe amounts to 2 percent, and is made up of a little fruit, a few seeds, and some rubbish. One seed and a stem of a fig were the only indications of cultivated fruit. Remains of elderberries were noted in 3 stomachs, seeds in 4, pulp of a large seed or nut in 1, and rubbish in 4.

SUMMARY.

The economic relations of the Say phoebe depend wholly upon its animal food, for it eats practically no vegetable matter of any interest to man. That it takes a few useful insects can not be denied, but the stomachs' contents show that they are far outnumbered by harmful species, and the balance is clearly in favor of the bird.

BLACK PHOEBE.

(*Sayornis nigricans.*)

The black phoebe inhabits the lower valleys of California, and in most parts can be found throughout the year. For a nest site it selects the wall of a canyon, a shed, the overhanging eaves of a barn, or, better still, a bridge. It has a pronounced preference for the vicinity of water. Even a watering trough by the roadside usually has its attendant phoebe.

While camping beside a stream in California, the writer observed the feeding habits of the black phoebe. The nesting season was over, and apparently the birds had nothing to do but capture food. This they appeared to be doing all the time. In the morning, at the first glimmer of daylight, a phoebe could always be seen flitting from rock to rock, and probably it caught an insect on each flight. This activity was kept up all day. Even after supper, when it was so dark that notes had to be written by the aid of the camp fire, the phoebes were still hunting insects.

Observations like these convince any reasoning person that the number of insects destroyed in a year by this species is something enormous, and the examination of stomachs confirms field observations. This bird eats a higher percentage of insects than any flycatcher yet studied except the western wood pewee. For the study of this phoebe's food 333 stomachs were available, collected in every month in the year and from various parts of the State. They show 99.39 percent of animal matter to 0.61 percent of vegetable.

Animal food.—In examining the food contained in the stomachs of the black phoebes, account was kept of the beetles that are generally supposed to be useful, namely, the ground beetles (Carabidæ), the ladybirds (Coccinellidæ), and the tiger beetles (Cicindelidæ). It was found that these beetles were eaten pretty regularly throughout the year; in fact, there is no month which does not show a certain percentage of them. The average for the year, however, is only 2.82, or practically 3 percent, not a heavy tax on the useful beetles. Other beetles, all more or less harmful, amount to 10 percent. They were eaten in every month, and though the quantity varies to some extent, the variation appears to be accidental.

Hymenoptera amount to over 35 percent of the yearly food. They were found in 252 out of the 333 stomachs, and in 11 there was no other food. They are eaten throughout the year. March is the month of least consumption, with only 1 percent, while August shows the maximum, nearly 60 percent. A few ants and several parasitic species are eaten, but the great bulk of this item is made up of wild bees and wasps. Not a trace of a honey bee was found in any stomach.

Hemiptera of several families were eaten to the extent of about 7 percent. They were pretty uniformly distributed through the food of the year, except that none were taken in May, which, however, is probably accidental. Four of these families are aquatic, which partly explains why the bird is so fond of the vicinity of water. The Reduviidæ are insectivorous, and therefore useful. They were found in but one stomach. The other families are vegetable feeders; all of them likely to be harmful, and most of them pests. The plant lice found in the food are rather unexpected, but, as already noted, flycatchers do not take all their food on the wing.

Flies (Diptera) were eaten by the black phoebe to the extent of over 28 percent. They appear in every month, and range from 3 percent in August to 64 percent in April. They were found in 127 stomachs, 10 of which contained nothing else. The house-fly family (Muscidæ), the crane flies (Tipulidæ), robber flies (Asilidæ), and one horsefly (Tabanidæ) were the only ones identified. Grasshoppers and crickets are not extensively eaten by the phoebe. They amount to about 2½ percent for the year, being eaten rather irregularly; five months show none at all. The greatest consumption was in April, nearly 8 percent.

Moths and caterpillars are eaten to the extent of 8 percent. They were found in 72 stomachs—moths in 38, caterpillars in 32, and both in 2. A few unidentified insects and several miscellaneous ones, principally dragonflies, with some spiders, make up the rest of the animal food, 6 percent. Dragonflies are taken quite frequently, but generally in no great numbers. One stomach was entirely filled with them, and several were nearly so. The fact is, these insects are so large that often a single one fills a phoebe's stomach. These insects are too strong and agile upon the wing to be captured by anything less expert than a flycatcher, and in the few instances where they appear in other birds' stomachs they were probably found dead. The spiders eaten by the phoebe are perhaps snapped from the tops of weeds as the bird flies over, or taken from the web. While quite frequently eaten, they form only a small percentage of the diet.

The following is a list of insects identified in the stomachs of the black phoebe:

COLEOPTERA.

Elaphrus riparius.
Trixena longula.
Bradycellus rupestris.
Laccobius ellipticus.
Philonthus pubes.
Hippodamia convergens.
Coccinella transversoguttata.
Coccinella californica.
Chilocorus orbus.
Cryptorhopalum apicale.
Hister bimaculatus.
Saprinus obscurus.
Saprinus lugens.
Saprinus lubricus.
Carpophilus hemipterus.
Heterocerus tristis.
Canthon sp.
Aphodius granarius.
Aphodius vittatus.
Aphodius ungulatus.
Amphicoma ursina.
Gastroidea sp.
Lina scripta.
Diabrotica soror.
Blapstinus pulverulentus.
Corphyra sp.
Notoxus alamedæ.

HEMIPTERA.

Hygrotrechus sp.
Largus succinctus.

In addition to the above species the following families of Hemiptera were identified:

Giant water bugs (Belostomatidæ).
Creeping water bugs (Naucoridæ).
Broad-shouldered water striders (Veliidæ).
Water striders (Hydrobatidæ).
Assassin bugs (Reduviidæ).
Leaf bugs (Capsidæ).
Red bugs (Pyrrhocoridæ).
Chinch-bug family (Lygæidæ).
Stink bugs (Pentatomidæ).
Leafhoppers (Jassidæ).
Tree hoppers (Membracidæ).
Jumping plant lice (Psyllidæ).
Plant lice (Aphididæ).

Vegetable food.—The vegetable food of the black phoebe amounts altogether to only 0.61 percent, and may be classified under two heads: Fruit and other vegetable matter. Fruit forms 0.34 percent, and the only species identified were elderberries in 19 stomachs, dogwood (*Cornus*) in one, and *Rubus* (blackberries or raspberries) in one. This last may have been cultivated; and some fruit skins found in 1 stomach may also have been of a domestic variety. Miscellaneous vegetable food consists of poison oak seeds in 2 stomachs, a catkin in 1, and rubbish in 1.

Food of young.—Among the 333 stomachs of the black phoebe were those of 24 nestlings, varying in age from 1 to 2 weeks. Their food was tabulated by itself to ascertain if it differed from that of the adults. No great difference was apparent in the kind of food eaten nor in the relative proportions. One point, however, was noted. The percentage of animal food was a little lower than in the adults; not because the young had intentionally eaten any vegetable food, but because, along with other food, the parents had fed a quantity of rubbish, dead grass, leaves, and the like. The same apparent carelessness as to the food of their young has been observed in other species.

SUMMARY.

In a summary of the food of the black phoebe the vegetable part may be dismissed as unimportant. Of the insect food we have less than 3 percent of theoretically useful beetles, a few parasitic Hymenoptera, and a few dragonflies, say, 5 percent in all, to offset 94 percent of harmful species. This phoebe is an efficient insect destroyer, and is an invaluable asset to the people of California or any other State it may inhabit. It should be rigidly protected and in every way encouraged.

WESTERN WOOD PEWEE.

(*Myiochanes richardsoni.*)

The western wood pewee is a familiar sight in the fruit-growing sections of the State, where its time is spent in a tireless search for insects. Wherever in the orchard there is a dead limb, there on the outermost twig perches the pewee, and from its lookout sallies forth to snatch up any luckless insect that comes within range. Several such perches are usually to be found not far apart, and the bird occupies them in turn as the game becomes scarce in one or the other place. The little western flycatcher (*Empidonax difficilis*) has the same habits, and shares these watchtowers with the pewee. Observation of one of these perches for three minutes, watch in hand, furnished a good idea of the bird's industry. In the first minute it took 7 insects, in the second 5, and in the third 6, or 18 in the three minutes.

Apparently it had been doing the same thing for an hour, perhaps all the morning. These observations were made at 10 a. m., when the air was warm and insects were on the wing. Either the same bird or another was watched the next day at 9 a. m. near the same spot, and 17 captures were noted in eight minutes. This morning was cooler, and fewer insects were abroad than on the previous day. The mean of these two observations is 4 insects per minute. If the bird keeps this up for even ten hours a day, the total is 2,400 insects. It hardly seems possible that one bird could eat so many unless they were very small, but this pewee is rarely seen when it is not actively hunting. When the young are in the nest, the parents must make great havoc with insects if the nestlings are fed at the above rate.

The pewee remains in California only about six months in the year, but fortunately this is the season when insects are most numerous. One hundred and thirty-seven stomachs, taken in the months from April to September inclusive, were available for examination. Animal matter formed 99.91 percent of the contents and vegetable matter 0.09 percent, or less than one-tenth of 1 percent. The percentage of animal matter is the highest yet found in the food of any flycatcher.

Animal food.—Beetles amount to about 5 percent of the food. With the exception of Carabidæ, found in 4 stomachs, and Coccinellidæ, in 5, all were either harmful or neutral species.

The following beetles were identified:

Coccinella 9-notata nevadica.
Coccinella californica.
Coccinella transversoguttata.
Hippodamia ambigua.
Hippodamia convergens.
Hister bimaculatus.
Saprinus plenus.
Carpophilus hemipterus.
Aphodius vittatus.
Agrilus sp. nov.
Agriotes sp.
Gastroidea sp.
Blapstinus sp.
Ptilinus basalis.
Baris rubripes.

Hymenoptera aggregate over 39 percent, and are of wild species—that is, there are no domestic bees among them. They were found in 93 stomachs, and in 14 there was nothing else. Parasitic species were identified in 7 stomachs and ants in only 2—an unusually small record for ants, which are favorite food with flycatchers.

Hemiptera, or bugs, are evidently not esteemed as an article of diet by this bird, for they amount to less than 2 percent of the food. None were eaten in April or May, but nearly half the whole number were taken in August.

Diptera amount to nearly 40 percent, slightly exceeding Hymenoptera. No other flycatcher has yet been noted whose food contained more Diptera than Hymenoptera; hence the name flycatcher is peculiarly applicable to this pewee. Diptera were found in 84 stomachs, and 20 contained no other food. This would seem to indicate that flies are preferred to other insects. The families Muscidæ, Tipulidæ, and Asilidæ were recognized.

Caterpillars and moths amount to nearly 5 percent. Though not taken in great numbers, they are eaten regularly through the season. September shows the greatest consumption—over 14 percent. Moths were found in 18 stomachs and caterpillars in 4. One stomach was entirely filled with the remains of moths.

Sundry insects, amounting to nearly 9 percent, make up the rest of the animal food. Dragonflies were found in 7 stomachs, and 1 contained nothing else. Ephemerids were in 4 stomachs, lace-winged flies in 1, spiders in 3, and the so-called jointed spiders in 1.

The character of the food shows that it is taken on the wing more exclusively than that of any other bird yet examined. Of the creatures that do not fly, ants were found in 2 stomachs, caterpillars in 4, spiders in 3, and jointed spiders in 1. As some ants fly, these may have been taken in mid-air, but they were too badly broken to determine this point.

Vegetable food.—Vegetable matter was found in 4 stomachs, but in 3 of these it was mere rubbish. One contained seeds of the elderberry, the only vegetable food observed.

SUMMARY.

The western wood pewee, while often an inhabitant of the orchard, does not deign to taste of its product, if the above record may be assumed to be conclusive. Its diet is composed almost exclusively of insects, and of these a large majority are harmful species.

WESTERN FLYCATCHER.

(*Empidonax difficilis.*)

The western flycatcher avoids alike the hot valleys and the high mountains of California during the warmer months, but is more generally distributed in migration. For a nesting site it selects a tree, a crevice among the roots of an overturned stump, a bracket under a porch, a beam under a bridge, or a hole under an overhanging sod on the bank of a stream. It has much the same liking for water as the black phoebe, though even more pronounced. A small stream running through or near an orchard appears to supply ideal conditions for this little flycatcher, as the orchard makes an excellent foraging ground, and if it does not afford a nesting site, the bank of the stream will. The bird is quiet and unobtrusive, and often the first notice one has of its presence is to see it dart from the end of a near-by twig into the air in pursuit of an insect. It seems to be thus engaged all day; in fact, the writer has never seen one of these birds when it was not in search of food.

In the laboratory investigation of the food of the western flycatcher 141 stomachs were examined. They were collected from March to October inclusive, and probably give a fair idea of the bird's food for these months. Analysis gives 99.28 percent of animal food to 0.72 percent of vegetable; in other words, there was less than three-fourths of 1 percent of vegetable matter. Only one other flycatcher, the western wood pewee, eats so little vegetable food.

Animal food.—In this analysis a separate account was kept of the ladybird beetles (Coccinellidæ). This bird appears to eat more of them than does any other flycatcher, but the number for the whole season is not large enough to be very serious. The greatest consumption occurred in August, a little more than 7 percent. The average for the season is 2⅓ percent. Other beetles amount to nearly 6 percent, nearly all harmful, the exception being a few ground beetles (Carabidæ).

Hymenoptera form the largest constituent of the food of this as of most other flycatchers. They amount to over 38 percent, and are an important item during every month of the bird's stay on its summer range. The highest percentage is in March, 61; but as only 3 stomachs were taken in that month, the record can not be considered as final. June shows 52 percent, and is probably nearer the true maximum, although August and September do not fall much below. Ants were found in 14 stomachs, and parasitic Hymenoptera in but 2. Hymenoptera in general were found in 99 stomachs, and 6 contained nothing else. No honeybees were identified.

Hemiptera (bugs) amount to nearly 9 percent of the food. They were found in 49 stomachs, 2 of which were entirely filled with them. The greatest number were taken in August, when they constituted 29 percent. The following families were identified:

Stink-bug family (Pentatomidæ).
Chinch-bug family (Lygæidæ).
Leaf-bug family (Capsidæ).
Leafhopper family (Jassidæ).
Tree-hopper family (Membracidæ).

Diptera amount to a little more than 31 percent of the whole food. They rank next to Hymenoptera, and, like those insects, are taken very regularly during every month of the bird's stay in the State. While October is the month of maximum consumption, 47 percent, several other months are but little below. Only 3 families were identified: The crane flies (Tipulidæ), the soldier flies (Stratiomyiidæ), and the house flies (Muscidæ).

Lepidoptera, in the shape of moths and caterpillars, amount to about 7 percent for the year, and were found in every month except March. They appeared in 36 stomachs, of which only 7 contained the adult insects—moths—and 29 the larvæ or caterpillars. This taste is in contrast with that of the black phoebe and the wood pewee, which prefer moths, but is quite in accordance with the general rule among insectivorous birds. Special interest attaches to this item of the bird's food from the fact that larvæ of the codling moth were found in 3 stomachs. In one 15 were counted, which amounted to 89 percent of the food. In another they were too badly broken to be counted, but formed 55 percent of the contents. In the third only 1 was found, amounting to 3 percent. Evidently these insects were hibernating in a crevice in the bark of a tree or some similar place, and were there discovered by the flycatcher.

A few unidentified insects and some spiders make up the remainder of the animal food—about 6 percent. Spiders were found in 19 cases—in 1 stomach amounting to 70 percent—and these, with the caterpillars, particularly the codling-moth larvæ, show that a considerable percentage of the food of this bird is not caught on the wing.

The following is a list of insects identified from the stomachs of the western flycatcher:

COLEOPTERA.

Aleochara bimaculata.
Hippodamia ambigua.
Hippodamia convergens.
Coccinella californica.
Scymnus sp.
Telephorus divisus.
Aphodius sp.
Limonius infuscatus.
Gastroidea cyanea.
Diabrotica soror.
Monoxia sordida.
Epitrix sp.
Eulabis rufipes.
Blapstinus ruficeps.
Deporaus glastinus.
Balaninus sp.

DIPTERA.

Stratiomyia maculosa.

LEPIDOPTERA.

Carpocapsa pomonella.

Vegetable food.—Vegetable matter was found in 16 stomachs, though some of it could not properly be called food. One stomach contained seeds of Rubus fruit (blackberries or raspberries); 7, seeds of elderberries; 1, the skin of an unidentified fruit and a seed of tarweed (*Madia*); while 6 held rubbish. The Rubus fruit might have been cultivated, but probably was not.

Food of young.—Among the stomachs whose contents have been discussed were those of 15 nestlings, varying in age from 48 hours to 2 weeks, which show no marked differences from those of adults. Only 2 of these stomachs contained any vegetable matter; in 1 was 15 percent of rubbish; in the other 3 percent. Gravelstones were found in several cases, and have been observed in the young of other insectivorous birds, even when not found in adults of the same species.

The young in one nest were fed 24 times in an hour. Owing to the nest's location the number of nestlings was not ascertained. If there were four, as is probable, and the feeding was continued fourteen hours, each was fed 84 times during the day.

SUMMARY.

From the foregoing it is evident that neither the farmer nor the fruit grower has anything to fear from the western flycatcher. Practically it eats no vegetable food, and its animal diet contains less than the normal proportion of useful elements. It should be rigidly protected at all seasons.

OTHER FLYCATCHERS.

Four or more other species of the genus *Empidonax* occur within the limits of California. They are not so domestic as the one just discussed, but their food habits are quite similar. One, *E. trailli*, is locally quite abundant, but chooses the willows along water courses for its home rather than the orchards. The others are less widely distributed and therefore of less economic importance. A few stomachs of each species have been examined, but they indicate no remarkable differences in food habits from those of the western flycatcher.

HORNED LARK.

(*Otocoris alpestris chrysolæma*, *rubida*, and other subspecies.)

Not only in California, but in a considerable portion of temperate North America, some form of the horned lark occurs wherever plain or valley presents the condition suited to its peculiar needs. The former generic name, *Eremophila*, or desert lover, was peculiarly appropriate, but unfortunately it was necessary to displace it. Bare, level ground with scant herbage and no trees or shrubs appears to be the ideal condition for the horned lark. While on the Pacific coast they are not called upon to endure excessive cold, yet elsewhere they endure low temperatures not only with indifference but with apparent pleasure. The writer has met them on an open prairie when the temperature was nearly 30 degrees below zero, and though a fierce gale was blowing from the northwest they did not exhibit the least sign of discomfort, but rose and flew against the wind, then circled around and alighted on the highest and most windswept place they could find. Probably they remain through the night in these bleak spots, for they may frequently be seen there after sunset. Most animals seek shelter from wind and cold, even though it be nothing but the leeward side of a ridge or hummock, but the horned lark refuses to do even this, and by preference alights on the top of the knoll where the wind cuts the worst. It seems strange that in so small a body the vital heat can be maintained under such adverse conditions, but if one of these birds be examined, its body will be found completely covered with a thick layer of fat, like the blubber on certain marine animals. This indicates that horned larks have plenty to eat, and that their food is largely carbonaceous. The necessity for such heat-producing food does not exist in the case of the California horned larks, but nevertheless they eat the same substances as those in a colder climate, although probably in reduced quantities.

The food of this bird consists largely of seeds picked up from the ground. Very naturally a bird that subsists on scattered seeds would pick up kernels of grain if they came in its way, and some persons have declared that this bird does serious damage to newly sown grain. As they sometimes associate in immense flocks, they may do harm when large numbers alight on a field before the grain has been harrowed in. Drilling the grain, which is the modern method, will obviate this trouble. Most of the grain eaten by these larks is waste from the harvest field.

For the investigation of the food of the horned larks of California, 259 stomachs, collected in every month except May, were available. While very irregularly distributed through the year, they probably give a fair idea of the annual food. In the analysis of the contents of these stomachs, approximately 9 percent of animal food was found to 91 percent of vegetable.

Animal food.—The horned lark is essentially a vegetarian, but eats a considerable number of insects during the reproductive season and feeds many to the young. Most of the animal food was taken between March and June, inclusive. The latter has the highest record, nearly 30 percent. As this lark is an early breeder, it begins eating insects early in the season. After June there is a rapid decrease in animal food, and the stomachs taken in November contained none whatever.

For convenience this part of the diet may be divided into the two items, beetles and other insects. Beetles amount to about 5 percent. Like the animal food in general, they were found in greatest quantities in the stomachs taken from March to June, the latter month showing a little over 20 percent. While a few predaceous ground beetles were eaten, the great bulk of these insects were of harmful species, among which were some snout beetles or weevils. The remainder of the animal food, 4 percent, consisted of bugs, ants, caterpillars, and a few miscellaneous insects and spiders. Of these, the greater number are either harmful or neutral.

Vegetable food.—The great interest in the food of the horned lark centers about the vegetable part. This consists of grain and weed seed. Corn was found in only one stomach. Wheat was contained in 21 stomachs, taken in four months: January, February, June, and July. The irregularity in eating grain would seem to indicate that it is not a favorite food. The midsummer records may be explained on the ground that these are the harvest months in California. But it is not supposable that wheat could be obtained in January and February and not in December or March. The greatest amount was eaten in February, 74 percent, but only 5 stomachs were taken in this month, and probably a greater number would have given a lower percentage. The average for the year is 9 percent. Of all the grains, however, oats are the favorite with the horned larks, as they are with so many other seed-eating birds. They were eaten much more regularly than wheat and in greater quantities. They were found in 142 stomachs, and November gives the highest record, 77 percent, while June has the lowest, a little over 8 percent. The average for the year is 31 percent. If all these oats were taken from the farmer's crop it might be a serious tax, but evidently only a few of them are so obtained. Those eaten in March may have been from newly sown fields, and those in June and July from the ripening crop, but the rest must have been waste grain gleaned from the fields, Moreover, California is covered with wild and volunteer oats, which, ripening at other times than the cultivated ones, furnish an inexhaustible supply of food for many birds. It is certain that most of the oats eaten by the California horned larks are either waste or volunteer grain, and have no economic value.

The particular food of horned larks is the seeds of weeds and grasses. These aggregate 51 percent of the annual diet, being eaten in every month, and constitute a respectable percentage of the food in each. The month of least consumption is January, when they amount to over 19 percent; August shows the maximum quantity, nearly 99 percent, but as only 4 stomachs were taken in this month, probably ample material would reduce this high percentage. It is by the consumption of weed seed that the horned lark makes amends for doing a little damage to grain. The quantity of seeds of noxious weeds destroyed annually by this species throughout the country is very great. Fruit does not appear in the stomachs of horned larks. The bird asks nothing of the orchardist—not even the shelter of his trees.

SUMMARY.

In the final analysis of the food habits of the horned lark there is but one tenable ground of complaint, namely, that it does some damage to newly sown grain. This can be largely remedied by harrowing in immediately after sowing, and can be wholly prevented by drilling. The bird's insect diet is practically all in its favor, and in eating weed seed it confers a decided benefit on the farmer. It should be ranked as one of our useful species, and protected by law and by public opinion.[a]

JAY FAMILY.

The jays have acquired a questionable reputation owing to the fact that they pilfer the nests of other birds and prey upon the farmer's crops. That at times they are guilty of both of these sins can not be denied. On the first of these counts the California jay is far more culpable than its eastern relative and does entirely too much nest robbing for the best interests of the State. It is also a despoiler of fruit in its season, and in this respect should be restrained. On the other hand, jays are conspicuous and ornamental elements in the bird fauna, and inasmuch as they consume many harmful insects, should not be wholly condemned.

Some half dozen species and subspecies of jays occur in California. The food of the two most important species is discussed in the following pages.

STELLER JAY.

(*Cyanocitta stelleri frontalis* and *carbonacea.*)

The Steller jay inhabits the mountains and forested areas of California throughout the year. It sometimes ventures to the edges of the valleys and occasionally visits orchards for a taste of fruit, of which it is very fond, but in general it keeps to the hills and wilder parts of the canyons. It is fond of coniferous trees and is likely to be found wherever these abound. Where ranches have been established far up the canyons among the hills, this jay visits the ranch buildings. While it has all the characteristics of the jay family, it is rather more shy than either the California jay or the eastern bluejay.

To determine the nature of the food of this species, 93 stomachs were available. They were distributed over the whole year except February and April. The contents consisted of animal food to the extent of 28 percent, and vegetable matter 72 percent.

Animal food.—Beetles amount to a little more than 8 percent: Carabidæ were found in 8 stomachs; all the others were of noxious species. One stomach was half filled with a species of weevil or snout beetle (*Thricolepis inornata*), of which 35 individuals were counted, and there were probably more. Hymenoptera amount to about 11 percent and are the largest item of animal food. They were found in 30 stomachs altogether, and 2 were entirely filled with them. Ants were found in only 2 stomachs. Three honey bees were identified, one in each of 3 stomachs. One was a worker, another a drone, and the third indeterminate. None of the smaller parasitic Hymenoptera were identified. The greater part of this item of food consisted of wasps and wild bees, which would indicate that this bird is an energetic and expert insect catcher.

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[a] For a more complete account of the food habits of the horned lark, see Bulletin No. 23, Biological Survey, U. S. Department of Agriculture, The Horned Larks and their Relation to Agriculture, by W. L. McAtee, 1905.

Hemiptera (bugs) are evidently not in favor with the Steller jay. They were found in but few stomachs and in small numbers and amount for the year to little more than 1 percent. Pentatomidæ, or stinkbugs, and Scutelleridæ, or shield bugs, were the only families identified. Diptera form only four-tenths of 1 percent. They were found in only 3 stomachs, taken at the same place and at the same hour. They consisted of crane flies (Tipulidæ) filled with eggs.

Orthoptera (grasshoppers and crickets) aggregate about 3.5 percent. They appeared in 28 stomachs and were the sole contents in one. Caterpillars and moths amount to a little more than 2 percent. The former were found in 17 stomachs and the latter in 2.

The following insects from the stomachs of the Steller jay were identified:

COLEOPTERA.

Sinodendron rugosum.
Dichelonycha fulgida.
Clerus sphegus.
Thricolepis inornata.

HYMENOPTERA.

Apis mellifera.

Of miscellaneous creatures, spiders were identified in 3 stomachs, raphidians in one, and sow bugs (*Oniscus*) in one; altogether they make up about one-half of 1 percent. Remains of vertebrates amount to a little more than 1 percent. They consist of hair and skin of a mammal found in one stomach, two bits of bone, probably of a frog, in one, and eggshells in 13. This last item is the worst in this jay's record, since it indicates that the bird is guilty of eating the eggs of smaller birds; but even this is not as bad as it looks. Only 6 of these egg-eating records occurred in June, the nesting month. All the rest were in September or later and were probably old shells picked up in abandoned nests or about ranch buildings or camp grounds.

Vegetable food.—The vegetable food may be divided into fruit, grain, mast, and miscellaneous matter. Fruit amounts to 22 percent and was found in 55 stomachs. Prunes were identified in 2 stomachs, cherries in 2, grapes in 2, Rubus fruits in 15, strawberries in 1, elderberries in 15, bay laurel fruit in 1, unknown wild fruit in 2, and fruit pulp, not fully identified but thought to be of cultivated varieties, in 16 stomachs. Thus 38 stomachs held fruit supposed to be cultivated. This number includes all containing Rubus fruits, which probably were not all cultivated—perhaps none of them were. The Steller jay undoubtedly eats considerable fruit, but most of its range lies in unsettled areas, and it is too shy to visit orchards, except those close to the timber. For the present, then, or until it becomes more domestic, the damage to cultivated fruit is likely to be small.

Grain amounts to 5 percent, and was found in 15 stomachs, distributed as follows: Wheat in 7, oats in 9, and barley in 1. Much of the wheat was damaged, and, in fact, owing to the times of year, it could not have been otherwise. The greatest amount of grain was taken in June, 24 percent, and was probably picked up in the harvest field. Many of the oats, perhaps all, were of the wild variety. The chief food of this jay, however, is acorns, though occasionally it eats other nuts or large seeds. Mast amounts to 42.5 percent of the yearly diet, and was found in 38 stomachs. In some of them it reached 99 percent of the contents. In October and November it amounted to 76 percent, in December to 90, and in January to 99 percent. Even in June, when other food was abundant, it was eaten to the extent of nearly 10 percent, though none was found in the stomachs taken in May or July. Very likely a considerable part of this was stolen from the stores of the California woodpecker, for it is hardly probable that the jays find acorns under the trees so late as June and so early as August. It is true the jays themselves store up nuts to some extent, but hardly on the scale indicated by the contents of their stomachs when the acorn harvest is long past. Seeds, galls, and miscellaneous matter make up the remainder of the vegetable food, about 2.5 percent. In two stomachs taken near the ocean were tangles of confervæ and other seaweeds.

SUMMARY.

From the foregoing analysis it will be seen that the food of the Steller jay is of minor importance from an economic point of view. In destroying beetles and Hymenoptera it performs some service, but it destroys only a few. Of the order of Hemiptera, which contains most of the worst pests of the orchardist and farmer, it eats scarcely any. The Orthoptera, which are almost all harmful insects, are eaten only sparingly, and the same applies to the rest of the insect food. The destruction of birds' eggs is the worst count against the jay. But none were found, except in June, until September, when it was too late in the season for fresh eggs to be obtainable. In June 17 birds were taken, and 6 of them, or 35 percent of the whole, apparently had robbed birds' nests. Now, it is evident that if 35 percent of all the Steller jays in California each rob one bird's nest every day during the month of June the aggregate loss is very great.

So far as its vegetable food is concerned, this bird does little damage. It is too shy to visit the more cultivated districts, and probably will never take enough fruit or grain to become of economic importance. The other vegetable food it consumes is entirely neutral from the economic standpoint.

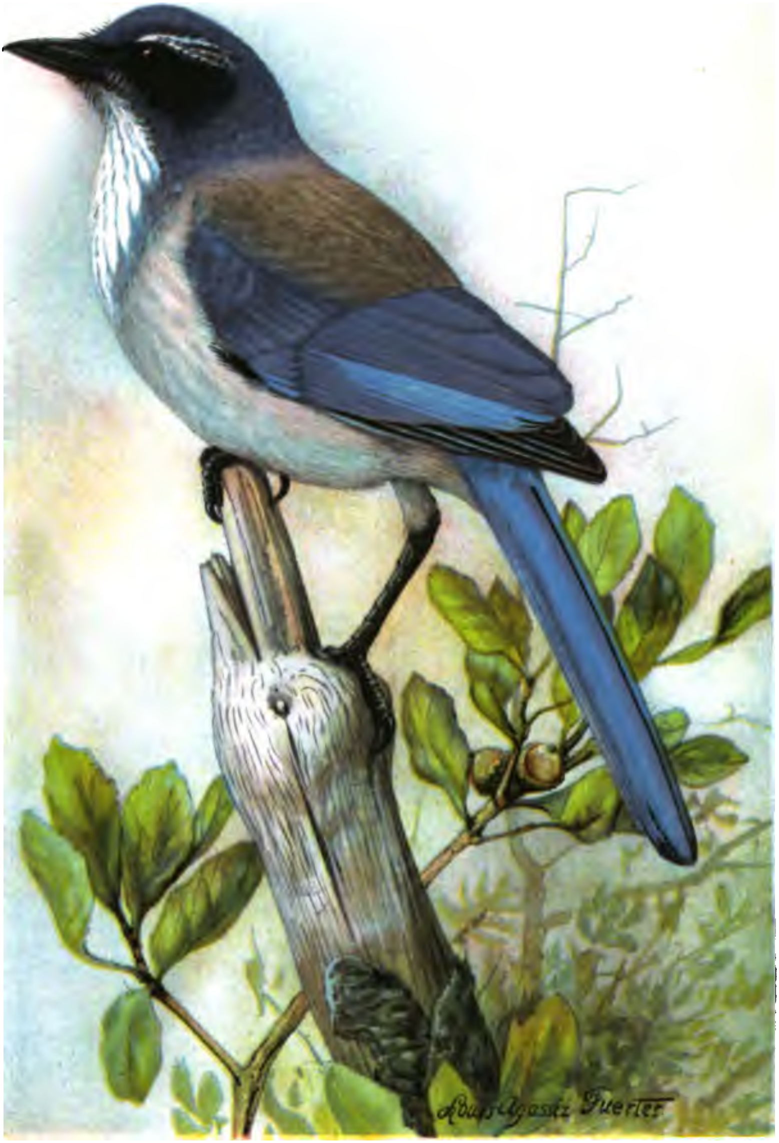
CALIFORNIA JAY.

(*Aphelocoma californica.*)

The California jay (Pl. III) occupies the warm chaparral-covered lower slopes of the Sierra Nevada and Coast ranges and adjacent valleys. He has the same general traits of character as the eastern jay, is the same noisy, rollicking fellow as that bird, and in California occupies a corresponding position in bird society. While for the most part a frequenter of woods and chaparral, he is by no means shy of visiting orchards and gardens, and will come even to the farm buildings if anything there interests him. A nest of the chipping sparrow (*Spizella passerina arizonæ*), which was being watched for notes on feeding, was robbed of its four nestlings early one morning by a jay, although not more than 30 feet from the front door of a house on the edge of the village. He is a persistent spy upon domestic fowls and well knows the meaning of the cackle of a hen. A woman whose home was at the mouth of a small ravine told the writer that one of her hens had a nest under a bush a short distance up the ravine from the cottage. A jay had found this out, and every day when the hen went on her nest the jay would perch on a near-by tree. As soon as the cackle of the hen was heard, both woman and bird rushed to get the egg, but many times the jay reached the nest first and secured the prize. A man living in the thickly settled outskirts of a town said that jays came every morning and perched on some large trees that overhung his barnyards, where the hens had their nests, and that it was necessary for some member of the family to be on the lookout and start at the first sound of the hen's voice or a jay would get the egg.

A still worse trait of the jay was described by a young man engaged in raising poultry on a ranch far up a canyon near wooded hills. When his white leghorn chicks were small, the jays would attack and kill them by a few blows of the beak, and then peck open the skull and eat the brains. In spite of all endeavors to protect the chicks and to shoot the jays, his losses were serious.

As a fruit-eater the jay has few equals. He has a pronounced taste for cherries and prunes, and where orchards of these fruits are near natural coverts, he will work unceasingly to carry off the fruit. The writer remained in a cherry orchard in such a situation from 9 a. m. to 4 p. m. on several occasions during the cherry season, and there was not an hour of that time that jays were not going away with fruit and coming for more, in spite of the fact that every one was shot that was unwary enough to give the collector a chance. A small prune orchard on some bottomland, just where a small ravine debouched from the wooded hills, was also watched. The fruit was just ripening, and a continuous line of jays was seen pass-



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CALIFORNIA JAY

ing from the hills down through the ravine to the orchard, while a return line, each jay bearing a prune, was flying up the ravine to the woods, where, probably, the fruit was secreted and left to rot. The jay habitually stores nuts and grain for future use, and no doubt, urged by a misdirected instinct, lays up fruit for the same purpose, but with a different result. Several hours later the jays were still at work. On another occasion 7 jays were shot successively from a prune tree loaded with fruit, and others continued to come, unterrified by the report of the gun or the dead bodies of their comrades that lay on the ground beneath the tree.

The jay is also a notorious pilferer of nuts, notably almonds and English walnuts. He is a skillful nutcracker, and extracts the kernel deftly by holding the nut between his feet on a branch, while he hammers it with his beak until he cracks the shell. Only the hardest nuts defy his powers. A gentleman who owned a large ranch situated in a canyon and on the surrounding hills planted a dozen or more almond trees to raise nuts for home use. When the trees came to bearing, the jays each year carried all the nuts away before they were ripe. "Although," said the owner, "the trees bear a fair crop, I never get a nut; the jays take them all." Another gentleman had a number of very large English walnut trees on his ranch, which was at the upper end of a wooded canyon. While these nuts were yet unripe, the jays destroyed a great many. Fortunately, when mature, they seem to be too hard for the jays to peck through, so the bulk of the crop was saved.

But the jays do not frequent orchards entirely for fruit. During May and June the writer many times visited an apple orchard, the leaves of which were badly infested with a small green caterpillar, locally known as the canker worm. When a branch is jarred, these insects let themselves down to the ground on a thread spun for the purpose. Many jays were seen to fly into the orchard, alight in a tree, and then almost immediately drop to the ground. Observation showed that the caterpillars, disturbed by the shock of the bird's alighting on a branch, dropped, and that the birds immediately followed and gathered them in. These caterpillars were found in the stomachs of several jays, in one case to the extent of 90 percent of the contents.

For the laboratory investigation of the food of the California jay, 326 stomachs were used. They were distributed through every month, but the greater number were taken from May to September, inclusive. As many of them as possible were collected about orchards, gardens, ranch buildings, and stock yards. In the first analysis the food divides into 27 percent of animal matter and 73 percent of vegetable. The greatest percentage of animal food occurs in April, when it reaches 70 percent. After that it decreases gradually to

January, when it falls to its minimum of a little less than 5 percent. Vegetable food, on the contrary, is most sparingly eaten in April and most abundantly in January.

Animal food.—As the jay is largely a ground feeder, careful account was kept of the predaceous ground beetles (Carabidæ). In May they amount to 10 percent of the food and to nearly as much in February; but in the other months they are insignificant. The total for the year is 2.5 percent. Other beetles, all either harmful or neutral, amount to a little more than 8 percent. They are eaten rather irregularly through the year. April shows the greatest consumption, nearly 31 percent, and January the least, only a trace.

Hymenoptera, in the shape of wasps, bees, and ants, amount to a little less than 5 percent. They were contained in 189 stomachs and were distributed as follows: Honey bees in 9, ants in 27, other Hymenoptera in 159. These figures illustrate the fact that a bird will eat a certain article of food very often, but in small quantities. While Hymenoptera amount to less than 5 percent of the food, they were found in nearly 58 percent of the stomachs. The honey bees, 20 in number, were found in 9 stomachs, and, what is very singular, all were workers. Birds that eat honey bees usually select the drones, but the jay appears to have chosen the workers. Fortunately he does not appear to eat many.

Hemiptera were eaten to the extent of less than one-half of 1 percent. One stomach contained 2 black olive scales (*Saissetia oleæ*). Diptera seem even less acceptable than bugs as an article of food. In July, the month of greatest consumption, there were less than 1 percent.

Lepidoptera (moths and caterpillars) amount to 2.5 percent. They were eaten in every month, mainly in the caterpillar stage. May was the month when the greatest number was eaten, nearly 10 percent. The most interesting point, however, in connection with this item of food is that 12 pupæ of the codling moth were found distributed through 8 stomachs. This is a most unexpected service from a bird of the jay's habits, and it may be said that a little work of this kind will cover a multitude of sins in other directions.

Orthoptera (grasshoppers and crickets) are eaten to the extent of 4.5 percent. Most of them were taken in July, August, and September. As usual, August stands first, with a consumption of nearly 17 percent, and one stomach contained the remains of 41 individuals. *Melanoplus devastator* was the only species identified. As the jay is, to a great extent, an inhabitant of the woods, it was natural that its stomach should contain quite a number of the brown wood cricket. A mole cricket also was found in one stomach. Orthoptera were found in 151 stomachs and formed the total food in one. When they are eaten so often, it is surprising that they do not form a larger percentage of the food.

A few miscellaneous creatures, such as raphidians, spiders, snails, etc., form less than one-half of 1 percent of the food.

The following is a list of insects identified in the stomachs of the California jay:

COLEOPTERA.

Amara conflata.
Silpha ramosa.
Limonius fulvipes.
Perothops witticki.
Onthophagus sp.
Diabrotica sp.
Coniontis robusta.
Blapstinus rufipes.
Sciopithes obscurus.
Balaninus sp.

HEMIPTERA.

Sinea diadema.
Saissetia oleæ.

HYMENOPTERA.

Apis mellifera.

LEPIDOPTERA.

Carpocapsa pomonella.

ORTHOPTERA.

Melanoplus devastator.

Besides the insects and other invertebrates already discussed, the jay eats some vertebrates. The remains consisted of bones or feathers of birds in 8 stomachs, eggshells in 38, bones of small mammals (mice and shrews) in 11, and bones of reptiles and batrachians in 13 stomachs. In destroying small mammals the jay is conferring an unmixed good, as practically all of them are injurious. His appetite for reptiles and batrachians, however, is unfortunate. These creatures, being mostly insectivorous, are very useful. Probably, however, their ranks are not seriously thinned by the jay. Of those eaten, 9 were lizards, one a snake, one a frog, and 2 others were batrachians, but could not be further identified. The great interest in the jay's vertebrate food, however, centers about the remains of birds and eggs. Of the 46 stomachs containing these remains, 17 were taken between the middle of May and the middle of July, and, as this period practically covers the nesting season in California, all may be considered as from the nests of wild birds robbed by the jay. The others represent either the eggs of domestic fowls or old eggshells. In the above period 95 stomachs were collected, of which 17, or 18 percent, contained eggs or remains of young birds. If we may infer, as seems reasonable, that 18 percent of the California jays rob birds' nests every day during the nesting season, then we must admit that the jays are a tremendous factor in preventing the increase of our common birds. Mr. Joseph Grinell, of Pasadena, after careful observation, estimates the number of this species in California at about

126,000. This is probably a low estimate. If 18 percent of this number, or 22,680 jays, each robs a nest of eggs or young daily for a period of sixty days from the middle of May to the middle of July, the total number of nests destroyed in California by this one species every year is 1,360,800. These figures are somewhat startling, representing as they do an enormous number of useful birds, and it is to be hoped they exaggerate the damage. For the present, however, they must stand for what they are worth. More data are necessary in order to determine fully the accuracy of the figures. Little weight attaches to the destruction of the eggs of domestic fowls by this jay, since in most cases it is easily preventable.

Vegetable food.—Aside from a few miscellaneous items, that altogether amount to less than 1 percent, the jay's vegetable food may be classed under three heads: Grain, fruit, and mast. Owing to the economic importance of this food the full tabulation is given below:

Month.	Grain.	Fruit.	Mast (acorns).	Month.	Grain.	Fruit.	Mast (acorns).
January	9.40	9.00	74.90	August	18.73	48.53	0.21
February	6.43	....	69.14	September	24.26	19.89	31.65
March	45.50	....	27.00	October	.29	....	88.57
April	5.00	....	24.75	November	....	11.14	66.29
May	2.43	61.41	.68	December	....	17.50	73.00
June	10.27	51.29	2.22				
July	18.42	44.94	.19	Average.	11.73	22.05	38.22

It will be seen that March holds the highest record for grain. This was probably picked up from fields newly sown. After that, not much is eaten until June, when the harvest begins. From that time on, grain is an important article of diet, and is obtained by gleaning in the harvested fields. It makes a sudden drop at the end of September, for at that time the acorn crop comes in. Grain was found in 95 stomachs, of which 56 contained oats; 34, corn; 2, wheat; 2, barley; and 1, grain not further identified. Many of the oats were of the wild variety.

Fruit was found in 270 stomachs. Of these, cherries were identified in 37, prunes in 25, apples in 5, grapes in 2, pears in 2, peaches in 1, gooseberries in 2, figs in 1, blackberries or raspberries in 71, elderberries in 42, manzanita in 4, cascara in 1, mistletoe in 1, and fruit pulp not further identified in 76. It will be noted that most of the fruit was eaten in the five months from May to September, inclusive. All found in November, December, and January was fruit pulp without seeds, evidently old fruit left on the trees. All the small fruits, as raspberries and elderberries, were taken during the summer months. The raspberries may have been either wild or cultivated, and were probably both; but in any case it is safe to say that half of the fruit eaten was of wild varieties and of no economic value.

Mast forms the largest item of the jay's food. This fact has some economic interest, since mast possesses considerable value as food for stock, especially hogs. A glance at the table will show the high percentages for the eight months from September to April inclusive, and then the sudden drop to the low rank it holds for the rest of the year. While the average consumption for the year is 38 percent, for these eight months alone it rises to nearly 57 percent, or more than half of the whole food. Doctor Merriam says that by the Indians this jay is called the oak planter. There is no doubt that all jays unconsciously aid in planting forest trees. Like the California woodpecker they habitually store up nuts and other large seeds, though unlike that bird they do not prepare storage places, but place them in forks of trees, cracks in old stumps or logs, behind loose pieces of bark, or bury them in the ground. Nuts are often dropped when being carried to a place of concealment, and sprout and grow to renew the forest.

SUMMARY.

The insect food, though small in amount, may be set down to the jay's credit. By the destruction of birds' eggs and young, it does serious mischief. Two items of its vegetable food, grain and fruit, are against the jay. In the case of grain, however, it is doubtful if much damage is done, since it is taken mostly after the harvest. If the grain taken in early spring is stolen from newly sown fields, it represents a real loss; but the jay is not known to pull up grain after it has sprouted, so that all it gets at this time must have been left uncovered, and is therefore of minor importance. After harvest it is common to see small companies of jays in fields, where they probably glean scattered kernels as well as some insects. In the matter of fruit stealing there are no extenuating circumstances. Wherever orchards are near its haunts, the jay is a persistent and insatiable fruit thief. If he took only what is necessary to satisfy the appetites of himself and family, he might be endured for the sake of his better traits. But long after his hunger is appeased, he continues to carry off fruit to store away, and thus his pilferings are limited only by his numbers and by the size of the fruit crop. Moreover, much of the fruit which he pecks is left on the tree to rot, and more falls to the ground unfit for use, except by pigs. It is fortunate that only orchards situated near the jay's usual haunts suffer severely. Those farther away are visited occasionally, but are not seriously damaged. Unlike many other birds which prey upon the earlier fruits, the jay continues his depredations as long as fruit is to be had. In an orchard closely watched by the writer it was found that when the earlier cherries were ripening, blackbirds, thrushes, orioles, grosbeaks, cedar birds, and linnets, as well as jays, were present in numbers, but two weeks later, when the earlier varieties were gone and the later ones were ripe, hardly any smaller birds were present, while the jays were as busy as ever; and still later, at the end of the season, when the prune crop came on, jays were still taking a heavy toll.

It will thus be seen that the jay has many more bad qualities than good. In fact, from the economic point of view he has few redeeming virtues. Something may be said in his favor from the esthetic side, as he is a handsome bird, and people interested in country life would no doubt miss his familiar presence. But as the case stands there are far too many California jays. If they could be reduced to a fourth or a half of their present numbers, the remainder would probably do no serious harm. This is exactly what is likely to take place gradually as the State becomes more thickly settled and forest and chaparral lands decrease.

BLACKBIRD, ORIOLE, AND MEADOWLARK FAMILY.

(*Icteridæ.*)

The family which includes the orioles, blackbirds, and meadowlarks embraces species widely different in form, plumage, nesting habits, and food. The orioles nest in trees and obtain the greater part of their food thereon. The blackbirds nest upon low trees, bushes, or reeds, and take their food from trees to some extent, but mostly from the ground. The meadowlarks, the most terrestrial of all, nest upon the ground and obtain nearly all of their food there. Orioles eat the greatest percentage of insects, the meadowlarks eat a little less, while the blackbirds eat the least. Blackbirds rank next to sparrows as eaters of weed seeds, especially in winter.

Besides the Brewer blackbird there are in California 5 species and subspecies of redwinged blackbirds, which are so much alike that most of them can be distinguished only by ornithologists. All have practically the same nesting habits, and their food is not essentially different.

BICOLORED REDWING.

(*Agelaius gubernator californicus.*)

The bicolored redwing is distributed locally over a large part of California, but owing to its peculiar habit of building its nest directly over water, the areas it occupies are restricted. Flooded marshes and ponds overgrown with bulrushes or tules are much to its taste, affording abundant nesting sites. Such places are common in California and many are of large extent—as those on Suisun Bay and in the Sacramento and San Joaquin valleys. Among these the bicolored redwing and his redwinged relatives find congenial quarters.

For the laboratory investigation of the food of this species, 198 stomachs were available. They were collected in every month of the year, and probably give a fair idea of the bird's food. It was found to consist of 14 percent of animal matter to 86 of vegetable. The animal food is practically all insects, and the vegetable either grain or weed seed.

Animal food.—Most of the animal food was taken in May, June, and July. May stomachs showed the maximum of nearly 91 percent. There is a sudden rise in the amount from April to May and a sudden fall from July to August. The insects composing this part of the food were distributed among several of the most common orders, but none of them appear to be specially sought after. Beetles aggregate about 5 percent. A few were predaceous ground beetles, but the most were either leaf beetles (Chrysomelidœ) or weevils. Hymenoptera, in the shape of wasps and ants, were taken very sparingly in the four months from May to August inclusive, and amount to about one-fourth of 1 percent for the year. Bugs were eaten during the six warmer months, and for the year aggregate just 1 percent. Grasshoppers constitute over 15 percent of the food in July. They are a fraction of 1 percent for the other months and average 1.5 percent for the year.

Caterpillars aggregate 5.5 percent, the highest of any item of animal food. In May they amount to over 45 percent of the food of that month, which is more than for all the other months together. Probably they are fed largely to the nestlings, as a few taken in May had eaten a large percentage of these insects. It is worthy of special notice that the caterpillar known in the cotton-raising States as the cotton bollworm, and elsewhere as the corn-ear worm, *Heliothis obsoleta,* was found in 7 stomachs. This is certainly to the credit of the bird, and it may be that its visits to cornfields are for this insect primarily, and that corn is taken only incidentally. A few miscellaneous insects amount to less than 1 percent and complete the animal portion of the diet.

The following are the insects identified in stomachs of the bicolored redwing:

COLEOPTERA.

Elaphrus ruscarius.
Gastroidea cyanea cæsia.
Chætocnema minuta.
Systena ochracea.
Notoxus alamedæ.
Apocrypha dyschirioides.

LEPIDOPTERA.

Heliothis obsoleta.

Vegetable food.—Two prominent constituents make up the vegetable food of the redwing—grain and weed seed. Grain amounts to 70 and weed seed to 15 percent. The grain consists of corn, wheat, oats, and barley. Oats are the favorite. They amount to over 47 percent of the yearly food, and were eaten in every month except February, when they were replaced by barley. The month of maximum consumption was December, when nearly 72 percent was eaten, but several other months were nearly as high. Wheat stands next to oats in the quantity eaten, nearly 13 percent. It is taken quite regularly in every month except March and May. Barley was found only in stomachs taken in February, October, and November, and nearly all of it was taken in February. The average for the year is 5.5 percent. Corn is eaten still less than barley, and nearly all was consumed in September, when it reached nearly 46 percent of the month's food. A little was eaten in May, August, and October, but the aggregate for the year is only slightly more than 4 percent.

Weed seed amounts to 15 percent of the food of the bicolored redwing. It is eaten in every month except May, when it gives way to animal food. The following species were identified:

Sunflower (*Helianthus* sp.).
Tarweed (*Madia sativa*).
Bur clover (*Medicago denticulatum*).
Alfilaria (*Erodium cicutarium*).
Red maids (*Calandrinia menziesi*).
Pigweed (*Amaranthus retroflexus*).
Chickweed (*Stellaria media*).
Catchfly (*Silene* sp.).
Smartweed (*Polygonum*).
Sorrel (*Rumex* sp.).
Canary seed (*Phalaris caroliniana*).
Sedge (*Carex* sp.).

These seeds were eaten very regularly throughout the year. The greatest consumption is in March, 35 percent, but as the record for several other months does not fall much below, probably this has no special significance. All of the above weeds are more or less of a nuisance, though at times some of them may be used as forage plants. Fruit is not eaten by the bicolored redwing.

Food of young.—Among the stomachs of the bicolored redwing were 11 of nestlings varying in age from 4 days to 2 weeks. The food was made up of 99 percent of animal matter and 1 percent of vegetable, though most of the latter was mere rubbish, no doubt accidental. Caterpillars were the largest item, and amounted to an average of 45 percent. Beetles, many of them in the larval state, stood next, with 32 percent. Hemiptera, especially stinkbugs and leafhoppers, amounted to 19 percent. A few miscellaneous insects and spiders made up the other 3 percent. It will be noted that the food of the young is practically all animal and that a preponderance of caterpillars and beetle larvæ makes it softer than that of the adults.

SUMMARY.

In summing up the facts relating to the food of the bicolored redwing, the most prominent point is the great percentage of grain. Evidently if this bird were abundant in a grain-raising country it would be a menace to the crop. But no complaints of the bird's depredations on grain have been made, and it is significant that the grain consumed is not taken at or just before the harvest, but is a constant element of every month's food. As the favorite grain is oats, which grows wild in great abundance, it must be admitted that, with all its possibilities for mischief, the bird at present is doing very little damage. So far as its insect food goes, it does no appreciable harm and much good. Its consumption of weed seed is a positive benefit. Like the other redwings, it has interesting habits and a pleasant song, and for the present, at least, should be protected.

OTHER REDWINGS.

In addition to the stomachs of the bicolored redwing, a few of 2 other species of redwings have been examined. They comprise 16 stomachs of the tricolored redwing (*Agelaius tricolor*), and 12 of the western redwing (some form of *A. phœniceus*). From the examination of so small a number, final data on the food can not be obtained, but so far as the testimony goes, it indicates that both species consume more insects and less grain than the bicolored. The stomachs of the tricolored contain 79 percent of animal matter to 21 of vegetable. The animal matter consists mostly of beetles and caterpillars, with a decided preponderance of caterpillars. The vegetable food is nearly all weed seed. One stomach alone contained barley.

In the case of the western redwings, the animal food amounted to 63 percent to 37 of vegetable. The former was pretty evenly distributed among beetles, grasshoppers, and Lepidoptera (moths and caterpillars), and contained in addition a few aquatic insects. The vegetable food was largely weed seed. A little barley was found in one stomach, and one was filled with oats.

It is evident from the foregoing that the beneficial greatly outweigh the injurious elements in the food of these redwings.

BREWER BLACKBIRD.

(*Euphagus cyanocephalus.*)

The Brewer blackbird (Pl. IV) occurs over most of the cultivated districts of California. By choice it is a resident of fields, meadows, orchards, and about ranch buildings and cultivated lands generally. It takes the place on the Pacific coast occupied by the crow blackbird (*Quiscalus quiscula* and *æneus*) in the Mississippi Valley and farther east, and is so similar in appearance and habits that the eastern observer in California forgets that it is not the same species. It nests in bushes, weeds, and sometimes in trees, and is so gregarious that several nests are often built in the same vicinity. Large colonies frequently establish themselves near farm buildings, and feed freely in the stock yards and cultivated fields. When fruit is ripe these blackbirds do not hesitate to take a share, and they visit the orchard daily for the early cherries.

They claim a share of grain also, but do not appear to eat it at harvest time so much as afterwards. Mr. Walter K. Fisher, writing from Stockton, Calif., on November 12, 1897, reports them as feeding on newly sown wheat that had not been harrowed in, eating nearly all thus left exposed. He describes the birds as in such immense flocks in the grain fields that at a distance they looked like smoke rising from the ground, and says that stomachs of birds taken were full of wheat. On the other hand, Prof. A. J. Cook, of Claremont, Calif., says that he considered it one of the most valuable species in the State; and Mr. J. F. Illingsworth, of Ontario, Calif., in a paper read before the Pomona Farmers' Club,[a] speaks of it as a beneficial bird, which should be protected. Mr. O. E. Bremner, State horticultural inspector, in a letter to the Biological Survey, says:

> The cankerworm episode is quite a common one with us here. In one district, Dry Creek Valley, Sonoma County, there has been a threatened invasion of the prune trees by spring cankerworms several times, but each time the blackbirds came to the rescue and completely cleaned them out. I have often seen bands of blackbirds working in an infested orchard. They work from tree to tree, clearing them out as they go. If a worm tries to escape by webbing down, they will dive down and catch him in mid-air.

During the cherry season the writer observed these birds in the orchards, and collected a number of them. They were seen to eat freely of cherries, and the stomachs of those taken showed that a goodly proportion of the food consisted of cherry pulp. While these observations were being made, a neighboring fruit raiser began to plow his orchard. Almost immediately every blackbird in the vicinity was upon the newly opened ground, and many followed within a few feet of the plowman's heels in their eagerness to get every grub or other insect turned out by the plow. On another occasion an orchard was being watched while the far side was being plowed. A continual flight of blackbirds was passing in both directions over the observer's head, and practically all of them alighted on the newly plowed ground, fed there for a while, and then returned, probably to their nests. When plowing was finished and harrowing began, the blackbirds immediately changed their foraging ground, and followed the harrow as closely as they had accompanied the plow.

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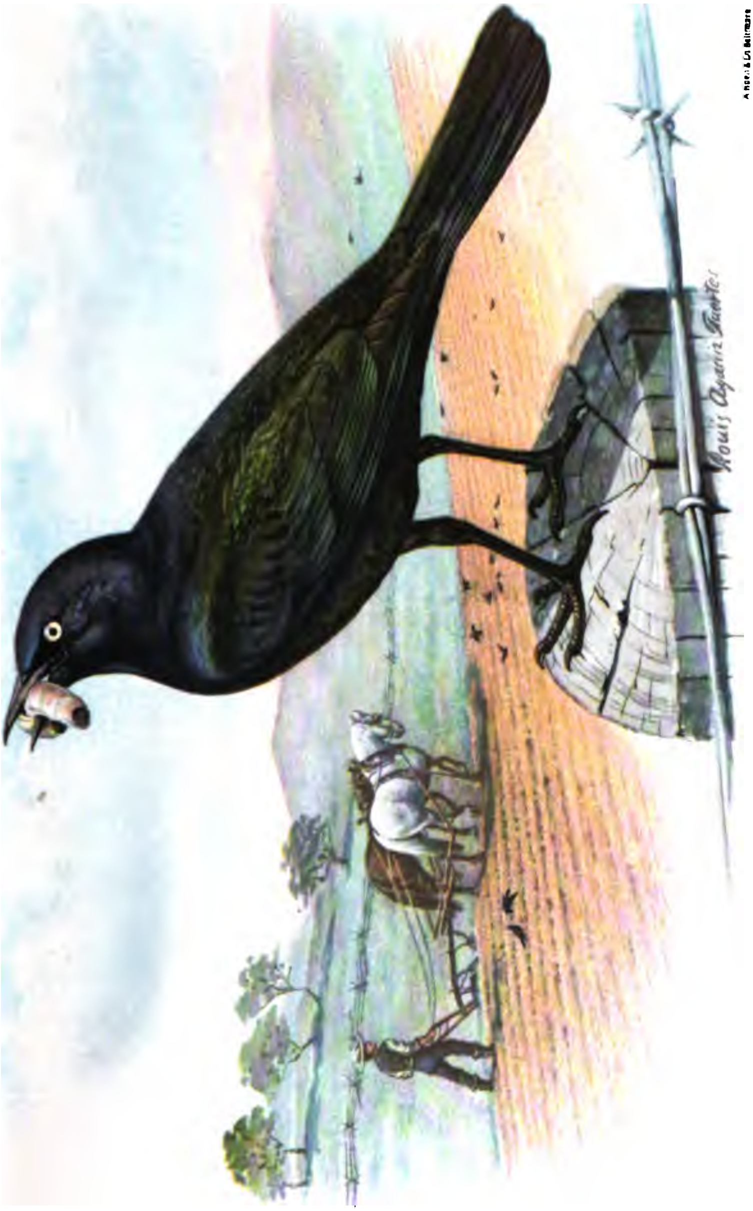
[a] Ontario Observer, June 3, 1899.

PLATE IV



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BREWER BLACKBIRD

In the laboratory investigation of this bird's food 312 stomachs were available. They were collected in every month in the year, and represent fairly the fruit and grain growing sections of the State from Santa Rosa southward. Many were taken in orchards and gardens when in the act of pilfering fruit or other products of husbandry. Besides adults, 29 nestlings of various ages are represented. The first analysis of the stomach contents gives 32 percent of animal matter to 68 of vegetable. The animal food consists of insects, spiders, sow bugs, snails, and eggshells.

Animal food.—The animal food attains its maximum in April, when it reaches 82 percent. From that time it slowly decreases until December, when it is only 5 percent, and then rises toward its maximum. The increase is very sudden from March to April. Beetles constitute over 11 percent of the food, and of these 2.5 percent are predatory ground beetles (Carabidæ). April is the month of greatest consumption of beetles, 29 percent, but no carabids are eaten in this month. In June 22.5 percent of beetles are eaten, of which 12 percent are carabids. The amounts eaten in other months are insignificant. The great bulk of the beetles eaten are the darkling beetles (Tenebrionidæ), which have much the same habit of living on the ground as the carabids, and are probably more abundant in California. One stomach was entirely filled with them. A few click beetles (Elateridæ) and some weevils were also eaten.

Hymenoptera (wasps, bees, and ants) were eaten to the extent of 1.7 percent of the food. Evidently blackbirds are too slow to catch often such agile creatures as wasps and bees. Hymenoptera were eaten in every month from March to November, inclusive. In June they amount to something over 7 percent, which is the maximum.

Bugs (Hemiptera) of various kinds are eaten from April to November to a small extent. They aggregate somewhat more than 1 percent for the year. In the month of greatest consumption, June, they reach only 5.5 percent. They belong mostly to the families of stinkbugs (Pentatomidæ) and shield bugs (Scutelleridæ). A black olive scale was found in one stomach. Flies (Diptera) were eaten to a slight extent from April to July inclusive, with a trace in October. The total for the year is only a little more than 1.5 percent. Like bees and wasps, flies are probably too quick to be easily caught.

Caterpillars and pupæ (Lepidoptera) reach the highest percentage of any item of animal food. They amount to nearly 12 percent, and are eaten in every month. April is the month when most are taken, over 38 percent, and the record for May stands nearly as high. They belong largely to the owlet moths (Noctuidæ), which comprise many of those pests generally known as cutworms. The cotton bollworm, or corn-ear worm (*Heliothis obsoleta*), was identified in 10 stomachs, and was probably contained in many more, but in a condition that baffled recognition. The most interesting Lepidoptera were the pupæ of the codling moth, found in 11 stomachs, 4 of which belonged to adults, while the other 7 were from nestlings, whose food will be discussed farther on. An orchardist told the writer that at one time his trees became infested with cankerworms, which swarmed all over the orchard and were rapidly destroying the leaves, when the blackbirds came in great numbers from all quarters and fed upon the worms until they were practically exterminated.

Grasshoppers and crickets were taken from April to November, inclusive, and amount for the whole year to 3.5 percent of the diet. In June they constitute over 15 percent of the food of that month, but only a moderate percentage was eaten in the other months. It is rather remarkable that birds which feed so much on the ground should eat so few of these insects, but this species appears to be mainly a vegetable eater, and to get the larger part of its animal food in April, just at its reproductive season, before grasshoppers are abundant.

Following is a list of insects identified in the stomachs of the Brewer blackbird:

COLEOPTERA.

Trixena scitula.
Trixena longula.
Bradycellus rupestris.
Scymnus lacustris.
Dermestes mannerheimi.
Saprinus obscurus.
Anchastus cinereipennis.
Aphodius rugifrons.
Aphodius granarius.
Diabrotica soror.
Diachus auratus.
Gastroidea sp.
Blapstinus pulverulentus.
Blapstinus rufipes.
Apocrypha dyschirioides.
Anthicus punctulatus.
Sitones sp.

HEMIPTERA.

Saissetia oleæ.

LEPIDOPTERA.

Heliothis obsoleta.
Carpocapsa pomonella.

Vegetable food.—The vegetable food reaches its maximum of 95 percent in December, when animal food is least plentiful. It may be divided into fruit, grain, and weed seed. Fruit was eaten in May, June, and July, not a trace appearing in any other month. It was found in 63 stomachs, of which 37 contained cherries (or what was thought to be such); 2, strawberries; 3, blackberries or raspberries; and 21, fruit pulp or skins not further identified. The percentages for each month were 14 for May, 22 for June, and 15 for July, an average of 17 percent for each of the three months, or of a little more than 4 percent for the whole year. This certainly is not a bad showing, and if the bird does no greater harm than is involved in its fruit eating, it is well worth protecting.

Grain constitutes 54 percent of the yearly food of the Brewer blackbird. It is eaten in every month, and forms a respectable percentage in each. The greatest amount is taken in December, 93 percent, and the least in April, 4 percent. Oats are the favorite grain. They amount to nearly 46 percent, and were found in 157 stomachs. Wheat amounts to nearly 3 percent, and was contained in 11 stomachs. Corn ranks next as to quantity eaten, less than 2 percent, but it was found in 17 stomachs. Barley occurred in only 5 stomachs, but amounted to a little more than 2 percent. Only 1 stomach held rye, but it amounted to more than 1 percent, for the stomach was nearly filled with it. Oats were the sole contents of 14 stomachs and wheat of 2. No stomach was completely filled with any other grain. Oats are evidently the favorite grain, whether we judge by the percentage eaten or by the number of stomachs containing them. Many of these were wild oats and of little economic value.

Weed seed amounts to nearly 9 percent of the food, and, while not consumed in large quantities, is eaten to some extent in every month. The greatest amount is taken in March, 26 percent. October comes next, with nearly 16 percent. The least is eaten in December and January, when grain is at its highest point. But little weed seed is eaten in May and June, when cherries demand attention. Weed seed was found in 134 stomachs, but in rather small quantities in each. No stomach was completely filled with it. It seems to be taken, moreover, rather irregularly, as though it were merely a makeshift. A few other odd items, mostly rubbish, amount to less than 1 percent, and complete the quota of vegetable food.

Seeds of the following uncultivated plants were identified:

Lesser tarweed (*Hemizonia fasciculata*).
Tarweed (*Madia sativa*).
Bur thistle (*Centaurea melitensis*).
Alfilaria (*Erodium cicutarium*).
Black mustard (*Brassica nigra*).
Miners' lettuce (*Montia perfoliata*).
Red maids (*Calandrinia menziesi*).
Pigweed (*Amaranthus retroflexus*).
Spurry (*Spergula arvensis*).
Chickweed (*Stellaria media*).
Catchfly (*Silene* sp.).
Knotweed (*Polygonum* sp.).
Brome grass (*Bromus* sp.).
Wild oats (*Avena fatua*).
Monterey pine (*Pinus radiata*).

Food of young.—Among the stomachs examined were those of 29 nestlings, varying in age from twenty-four hours to some that were nearly fledged. Taken altogether, the stomachs contained 89 percent of animal matter to 11 of vegetable. Over 74 percent of all was composed of caterpillars, grasshoppers, and spiders. Beetles in general amount to 6 percent of the food, or a little more than half the quantity eaten by the adults. Very singularly, however, 4.5 percent of these are carabids, or predatory ground beetles, nearly twice as many as are taken by the parent birds, although soft food is usually preferred for feeding nestlings. Caterpillars, with a few adult moths and some pupæ, aggregate 33 percent, which is three times as many as were eaten by the old birds. They were found in 22 of the 29 stomachs. The most interesting part of this item is 15 codling moth pupæ that were contained in 7 stomachs. Four adult stomachs also contained one each of these pupæ, but they seem to be mostly reserved as tidbits for the young. Grasshoppers and crickets were found in 21 stomachs, and aggregate 30 percent of the food, more than eight times as much as was eaten by the adults, so these insects also are evidently reserved for the nestlings. Spiders amount to 11 percent of the food of the young, although less than 1 percent of the parents' food. Various other insects and a few snails make up the rest of the animal food.

The vegetable food consists of fruit, grain, and rubbish. Fruit, probably cherries, was found in 4 stomachs of one brood. The average for each stomach was 43 percent. This was the oldest brood taken, and the birds were nearly ready to fly, which probably accounts for the large proportion of vegetable food. Oats, found in the stomach of one bird about a week old, amounted to about 45 percent of the contents, and seemed unusual food for so young a bird. The other two of the same brood had grass and other rubbish in their stomachs. Rubbish is the best term to describe the vegetable matter in most of these stomachs. The fruit and grain were all that should be called food.

One can not fail to notice the very pronounced difference in diet between these nestlings and the adults. Not only is the animal food of the young greatly in excess, but it is practically made up of spiders, caterpillars, and grasshoppers. All of these are comparatively soft-bodied creatures, and probably on that account are selected for the young.

SUMMARY.

In so far as its animal food is concerned, but little fault can be found with the Brewer blackbird. The insects eaten are fairly well distributed among the various orders, and include only a comparatively small number that are useful. As to fruit, no more is eaten than may be considered a fair return for the destruction of insects. The weed seed eaten must be set down to the bird's credit. All question, then, in regard to its economic position must rest upon the grain it eats. Most of the grain is taken in the months from August to February, inclusive. The average amount consumed in those seven months is over 75 percent of the food, while the average for the other five months is less than 24 percent, yet this last period covers the time from sowing to the end of harvest. As matters stand at present, probably the bird is doing no harm by eating grain, except perhaps under exceptional circumstances. It has a decided proclivity for oats, and if abundant would undoubtedly prove a menace to the crop.

WESTERN MEADOWLARK.

(*Sturnella neglecta.*)

Throughout California wherever grassy uplands, fields, and meadows occur, there will be seen the western meadowlark. Low, rich meadows, verging to marsh, with water near by, form ideal conditions for this bird. Nor does it disdain fertile hillsides when not too high, and when covered by a thick coat of herbage. Only professional ornithologists take note of the plumage differences between the eastern and western species of the meadowlark, but the difference in song is evident to the dullest ear. Owing to the snow, meadowlarks in the northern and eastern parts of the United States must migrate in winter far enough south to find open ground, but in California valleys no such necessity exists; so the bird remains on the same range the year round, and carries on its good work of destroying insects and weeds.

A few complaints have been made that meadowlarks in California eat the seeds of forage plants, notably clover, to an injurious extent. As most of the forage plants, including the introduced grasses of the Pacific coast lowlands, are annuals, the destruction of their seed would lessen the next season's feed and be a damage. Probably, however, such harm is done only under exceptional circumstances, for the stomachs show only a very small percentage of seed of forage plants and no clover seed. Another report is that the meadowlark does considerable damage to peas. The earliest fields are most visited by the birds, and small patches are sometimes almost completely destroyed. The later crops are not so badly damaged, and in extensive areas the loss is hardly noticeable. All the reports of damage to peas thus far received are from southern California, and very likely the explanation lies in some peculiar local conditions. The birds evidently lose their taste for this kind of food before the season is over, and probably find something more palatable which is wanting at first.

In some parts of the San Joaquin Valley the meadowlark has been accused, and probably with good reason, of pulling up sprouting grain in early spring. It is stated that the bird bores down beside the new plant and draws out the kernel. In many cases the amount of grain thus destroyed is said to be large. In one instance it was stated that the crop over a limited area was reduced 50 percent. The evidence, however, is conflicting, as some grain growers in the same localities are not aware of any loss. It thus seems probable that the damage to grain by the meadowlark is limited in extent and very local.

For the determination of the food of the meadowlark 91 stomachs were available, distributed throughout the year. The food consists of 70 percent of animal matter to 30 of vegetable. Broadly speaking, the animal matter is made up of insects and the vegetable of seeds.

Animal food.—Beetles are the largest item of the animal part of the diet. They are evidently a favorite food, for they are eaten in every month, with a good percentage in nearly all of them. The amount for the year is almost 27 percent. Practically half of this consists of the predatory ground beetles (Carabidæ). It is not surprising that the meadowlark should eat these beetles, for nearly all of them live on the ground, and walk and run much more than they fly; hence they are easily taken. As nearly all the species subsist largely upon other insects, their destruction must be considered as a flaw in this bird's record. All the other beetles eaten are harmful or neutral, and include a number of weevils. One stomach contained 36 yucca weevils (*Rhigopsis effracta*). The greatest number of beetles appears to have been eaten in March, when they amount to 72 percent, but as only two stomachs were available for that month the record is unreliable.

Wasps and ants (Hymenoptera) aggregate nearly 6 percent. They were eaten in every month but two, and ample material would undoubtedly show them in every month. Ants, being the more terrestrial, seem to be more natural food for the meadowlark than wasps or bees, but the bird gets a good share of both. Bugs (Hemiptera) were eaten to the extent of a little more than 4 percent. Nearly all of them were stinkbugs (Pentatomidæ). They were not eaten very regularly, and several months were not represented. May was the month of greatest consumption, 27 percent, but this may have been accidental.

Lepidoptera, largely caterpillars, aggregate about 15 percent. They were eaten in every month except August, when they were replaced by grasshoppers. February is apparently the month of maximum consumption, but a greater number of stomachs might prove differently. It is thought that many of these are of the kinds known as cutworms, though none were positively identified. All were undoubtedly terrestrial species, for the meadowlark is not known to seek food anywhere but on the ground.

Grasshoppers, when abundant, are usually eaten very freely by all ground feeding birds and by many arboreal species. The western meadowlark eats them to the extent of something more than 12 percent of its yearly food. This is a very small percentage for a bird of such terrestrial habits. The eastern form eats them to the extent of 29 percent, and in August the amount taken reaches 69 percent of the food of that month. With the western species the consumption reaches 42 percent in August, which is the maximum for the year. In the East the grasshopper season is limited to five months at most, but in California these insects can always be found. This makes it all the more surprising that California meadowlarks do not eat them more freely, but it is noteworthy that nearly every species of terrestrial bird in the East eats a larger percentage of these insects than does the related species on the Pacific coast. The actual percentage of grasshoppers proper eaten by the western meadowlark is even less than the above figures indicate, for the record includes quite a number of crickets, both the black and the brown or wood crickets (*Stenopelmatus*). One stomach contained 12 wood crickets. Crane flies (Tipulidæ), spiders, sowbugs (*Oniscus*), and a few snails make up the rest of the animal food, nearly 6 percent. More than half of this item consists of the crane flies (daddy longlegs) found in one stomach taken in April, in which they amounted to 45 percent of the stomach's contents.

The following insects were identified in the stomachs of the western meadowlark:

COLEOPTERA.

Calosoma externum.
Triæna longula.
Silpha ramosa.
Dolopius lateralis.
Taphrocerus gracilis.
Eurymetopon cylindricum.
Blapstinus dilatatus.
Rhigopsis effracta.
Sitones hispidulus.

ORTHOPTERA.

Stenopelmatus sp.

Vegetable food.—The vegetable food of the western meadowlark may be arranged under three heads: Fruit, grain, and weed seed. In one stomach taken in November was found something which was doubtfully identified as fruit pulp, but no other stomach contained a trace of fruit, and this bird has rarely been accused of eating fruit.

From August to March inclusive, grain is one of the most important articles of food. The average monthly consumption for the year is 27.5 percent, but for the eight months just indicated the average is 41 percent. In the other four months, that is, from April to July inclusive, which include the ripening and harvesting of the crop, no grain except a little corn was eaten. Grain of some kind was found in 60 of the 91 stomachs, and 4 were entirely filled with it. Corn is eaten only occasionally, and amounts to but 1 percent of the food. It was all taken in May and June. Wheat was eaten from October to January, inclusive. It amounts to over 11 percent for those months, but to less than 4 percent for the whole year. As is usual with grain eating birds, oats are the favorite kind. They were eaten from August to March inclusive, and average nearly 33 percent for those eight months, and for the year a little less than 22 percent. The greatest quantity, nearly 57 percent, was eaten in January, but nearly as much was taken in September. March, the month of seeding, shows the least, 10 percent. Barley was found in 6 stomachs taken in November, and amounts to less than 1 percent for the year.

Weed seed forms only 2 percent of the yearly food of the western meadowlark. With the eastern bird it aggregates a little more than 11 percent. It seems strange that a bird which obtains its food from the ground, and whose vegetable diet consists so largely of seeds, should neglect a food that furnishes sustenance to so many other species of birds. Weed seed was eaten so irregularly as to indicate that it was taken only as a makeshift. December was the month of greatest consumption, when it amounted to 15 percent.

SUMMARY.

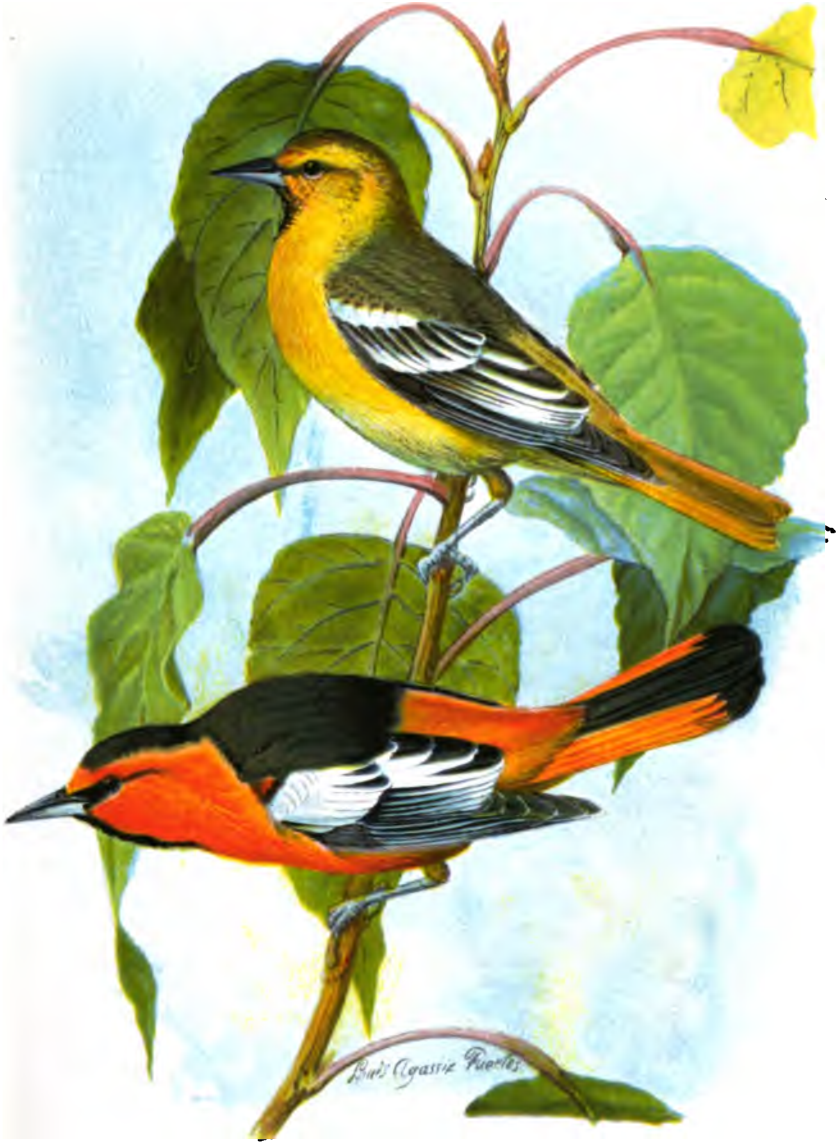
Three items of damage may be brought up against the meadowlark. The first is the destruction of predaceous ground beetles (Carabidæ), which amount to one-eighth of its food. This, however, constitutes but a small offense when we consider the number of caterpillars and grasshoppers which the bird also destroys. The damage to peas and grain when sprouting are undoubtedly real and in some cases serious, but the conflicting testimony in regard to these points indicates that this damage is due to local conditions, and it is probable that a careful study of the attendant circumstances will lead to a remedy.

In some communities, especially in the South and West, where meadowlarks are most abundant, there is a tendency to include them among game birds. The tiny body of the meadowlark, however, has slight food value as compared with the value of the living bird to the agriculturist. While the western meadowlark can not be classed in the front rank of the proved friends of the farmer, its services are sufficiently real and important to earn protection wherever it is found.

BULLOCK ORIOLE.

(*Icterus bullocki.*)

Over most of the plains and valleys of California, where trees are available for nesting and foraging, the Bullock oriole (Pl. V.) is a common summer visitant. In the West it takes the place occupied in the East by the Baltimore oriole. In food, nesting habits, and song the birds are similar. Both are migratory and remain on their summer range only about five or six months. They are rather domestic in habits, and take kindly to orchards, gardens, and the vicinity of farm buildings, and often live in villages and in the parks of large towns. Their diet is largely made up of insects that infest orchards and gardens. Their favorite foraging places are trees, where they may be seen examining every leaf in search of their customary food,



BULLOCK ORIOLE

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caterpillars and other leaf-haunting insects. When fruit trees are in bloom they are constantly busy among the blossoms, and probably save many of them from destruction.

For the investigation of the food of the Bullock oriole 162 stomachs were available. They were taken in the five months from April to August inclusive, and probably give a very fair idea of the food for those months. Analysis of the contents shows about 79 percent of animal matter to 21 of vegetable.

Animal food.—The animal food consisted mainly of insects, with a few spiders, a lizard, a mollusk shell, and eggshells. Beetles amounted to 35 percent, and all except a few ladybugs (Coccinellidæ) were harmful species. The coccinellids were found in 9 stomachs, but the percentage was insignificant. Many of the beetles were weevils, and quite a number belonged to the genus *Balaninus*, which lives upon acorns and other nuts. Ants were found in 19 stomachs, and 1 contained nothing else. Hymenoptera other than ants were found in 56 stomachs, and entirely filled 2 of them. Including the ants, they amount to nearly 15 percent of the food of the season. The month of maximum consumption was April, when they reached over 29 percent of the monthly food.

One of the most interesting articles of food in the oriole's dietary is the black olive scale (*Saissetia oleæ*). This was found in 45 stomachs, and amounted to 5 percent of the food. In one stomach these scales formed 87 percent of the contents; in another, 82; and in each of two others, 81 percent. In one of these 30 individual scales could be counted. Scales were evidently a standard article of diet. They were eaten regularly in every month of the oriole's stay except April. Hemiptera other than scales are eaten quite regularly. They amount to a little more than 5 percent of the food. The month of greatest consumption was July, when they formed over 13 percent. They were mostly stinkbugs, leafhoppers, and tree hoppers. Plant lice (Aphididæ) were found in one stomach.

Lepidoptera, in the shape of moths, pupæ, and caterpillars, are the largest item of the oriole's animal food. April, the month of the bird's arrival from the South, is the month of greatest consumption, nearly 63 percent. The month when the fewest are taken is July, not quite 8 percent. This also is the month when the Baltimore oriole eats the fewest caterpillars. For the Bullock oriole the average consumption during its summer stay is a little more than 41 percent against 34 percent by the Baltimore. Perhaps the most interesting point in connection with the Lepidoptera is the eating of the pupæ and larvæ of the codling moth (*Carpocapsa pomonella*). These were found in 23 stomachs, which shows that they are not an unusual article of diet. No less than 14 of the pupa cases were found in one stomach, and as they are very fragile, many others may have been present, but broken up beyond recognition. It is curious that the oriole should find these insects. During the greater part of their larval life they are concealed within the apple. When ready to pupate they crawl out and at once seek some place of concealment, such as a crevice in bark or among clods or rubbish, where they can undergo their changes. To find them, therefore, birds must hunt for them. This would be very natural work for woodpeckers, titmice, creepers, and nuthatches, but it seems a surprising habit for an oriole.

Grasshoppers probably do not come much in the oriole's way. They were eaten, however, to the extent of a little more than 3 percent. In June they rise to somewhat more than 11 percent, which is the maximum. August is the month in which most birds eat the greatest quantities of grasshoppers, but none of the orioles collected in that month had eaten any. In spite of the fact, however, that grasshoppers are eaten so sparingly, 2 stomachs, both taken in June, contained nothing else, and another had 97 percent of them.

Various insects and spiders, with a few other elements, make up the rest of the animal food, a little more than 5 percent. Spiders do not form any important percentage of the oriole's food, but are probably eaten whenever found. They were identified in 44 stomachs, but no great number appeared in any. The scales of a lizard were found in one stomach and the shell of a snail in another. Eggshells occurred in 8 stomachs, and one egg was apparently eaten when fresh.

Eggshells are often seen in birds' stomachs and in most cases are supposed to be empty shells, which have been thrown from the nest. In the examination of the stomachs of over 200 species of birds, eggshells have been found in some of the stomachs of a great majority of the species. While most of these may have been empty shells, some of the cases are very questionable, and it is probable that occasionally individuals of most species of birds yield to the temptation to eat a fresh egg when a favorable opportunity occurs.

Vegetable food.—Practically all of the vegetable food consists of fruit, which amounts to a little more than 9 percent. Other vegetable matter aggregating less than 2 percent is largely rubbish, probably taken accidentally. Fruit was eaten in the four months from May to August inclusive. The maximum quantity was taken in July, when it amounted to nearly 40 percent. It was found in 67 stomachs, of which 16 contained cherries; 11, figs; 5, blackberries or raspberries; 1, elderberries; and 34, fruit pulp not further identified. One stomach was entirely filled with the pulp and seeds of figs. While this is a high percentage of fruit, most of which is of cultivated varieties, it is probably well paid for by the destruction of harmful insects. It is doubtful if any fruit grower would be willing to sacrifice the oriole, with its brilliant plumage and cheerful song, even if it took more fruit than it now does.

SUMMARY.

From an esthetic point of view the Bullock oriole has few rivals, and from an economic standpoint it has only one fault—that it does eat some fruit. It is not, however, so abundant that its ravages are likely ever to become serious, and its present numbers should be strictly protected.

SPARROW FAMILY.

(*Fringillidæ.*)

The sparrow family embraces a large number of birds of wide distribution, great diversity of form, and considerable variation in food habits. They are in general characterized by short, stout, conical bills, with which they hull seeds or crush beetles and the toughest skinned fruit. They are the great seed eaters of the feathered race. The quantity of seeds of noxious weeds consumed by the host of sparrows, especially in winter, is enormous. While the great bulk of the food of this family consists of vegetable matter, most of the species eat some animal food during the period of reproduction, and feed their young upon it during the first two weeks of their lives. The sparrows proper, commonly known as finches, linnets, or buntings, are, with a few exceptions, of subdued colors and quiet habits and subsist mostly upon vegetable food. On the other hand, such aberrant forms as grosbeaks and towhees eat a certain amount of animal food throughout the year.

In California about 60 species and subspecies of sparrows proper have been recorded, besides about a dozen grosbeaks and towhees. Not all of these, however, have such habits as render them of economic importance, and as many of the subspecies do not differ essentially in their food they are treated together.

WILLOW GOLDFINCH.

(*Astragalinus tristis salicamans.*)

The willow goldfinch, while found over most of the State west of the Sierra, is very locally distributed. Its plumage is beautiful, and its song, while not remarkable for power or volume, is sweet and cheery. The western goldfinches, like the eastern, feed principally upon seeds, and seem to have a special taste for those of thistles. When one finds a ripe thistle head, he at once begins to pick out the seeds and scatter the down, at the same time making a great jubilation, as though he enjoyed the fun of seeing the down fly. This habit has earned for them the name of thistle bird. They are eminently seed lovers, and rarely eat anything else, except a few insects during the season of reproduction. The only mischief so far imputed to them is the eating of the seeds of useful plants, such as lettuce and other vegetables on seed farms. Investigation has failed, however, to find a case where the damage was considerable. The writer visited some of the largest seed farms in California and ascertained that while birds, especially goldfinches, ate some of the ripening seeds, the damage had never been serious enough to warrant any protective measures. The writer observed goldfinches feeding on lettuce seed, but the birds were few, and all they could eat would have no appreciable effect on the quantity of seed harvested.

One marked peculiarity of the goldfinches is their bibulous habits. They seem always in need of water, perhaps owing to the habit of eating dry seeds. The writer has seen more goldfinches drinking in one day than he has seen of all other species in his whole life.

Only 84 stomachs of the willow goldfinch were available for examination, but such is the uniformity of the food that a larger number would probably not give a very different result. No stomachs were taken in December, but all the other months were represented. The food for those months amounts to 5 percent of animal matter to 95 of vegetable. All the animal food was found in 10 stomachs, 9 being taken in March, April, and May, and 1, containing 2 larvæ, in September. Practically all the vegetable matter is seeds.

Animal food.—The animal food was composed entirely of 3 orders of insects: Bugs (Hemiptera), flies (Diptera), and caterpillars (Lepidoptera). Bugs were contained in 5 stomachs and were all plant lice (Aphididæ). They aggregated a little less than 2 percent. Flies were found in 1 stomach taken in April. They were in the shape of larvæ or maggots and amounted to less than one-half of 1 percent. Caterpillars were contained in 6 stomachs and aggregated less than 3 percent. Beetles, wasps, ants, and grasshoppers, which so often constitute the bulk of the animal food of birds, are entirely wanting in the stomachs of the willow goldfinch, as also are spiders.

Vegetable food.—Vegetable matter appeared in every one of the 84 stomachs, and 73 of them held no other food. Hulls of oats were found in 1 stomach taken in May. It amounted to 65 percent of the contents of that stomach, and was the only thing of economic value found in any one of the 84 stomachs. It amounted to less than one-half of 1 percent of the year's food. Seeds of various weeds come to over 91 percent of the diet, and are found in every stomach in every month. For seven months weed seed constituted the entire food. The following plants were identified: *Centaurea* or bur thistle in 18 stomachs, alfilaria or filaree in 13, sunflower in 12, groundsel in 4, mouse-ear, rust weed, and tarweed in 2 each. As the goldfinch takes a good deal of gravel into its stomach, many of the seeds are ground up so that recognition is impossible. A few stomachs contained a vegetable food that could not be identified, perhaps some large seed broken up and discolored. Two stomachs containing this substance were those of nestlings 12 days old. One was entirely filled with it, but the other contained 75 percent of caterpillars.

SUMMARY.

There are probably few birds that do so little harm as the willow goldfinch. Its animal food, though small in quantity, is composed entirely of harmful insects. It eats no fruit and practically no grain. Most of its food consists of the seeds of noxious or neutral plants. Its food habits commend the bird, as much as its bright plumage and fine song.

GREEN-BACKED GOLDFINCH.

(*Astragalinus psaltria hesperophilus.*)

The green-backed goldfinch (Pl. VI) occurs over most of California, except the mountains and the deserts, and is one of the most abundant birds. It is a lover of the orchard and garden, and delights to linger along the roads and in weed patches. Its favorite feeding grounds are in open pastures, where the bur thistle (*Centaurea melitensis*) grows, a plant specially adapted to the wants of the goldfinch, for it throws out from the roots short seed-bearing stalks that bear seed, while the rest of the plant is making growth and getting ready to produce the main crop. The goldfinches know where these seeds are, and apparently get every one of them. Next in favor is the groundsel (*Senecio*), which grows in orchards, and on the unripe seeds of which the goldfinches feed to repletion. In the investigation of the food of this bird 476 stomachs were examined. They were taken in every month, and are well distributed. Animal food amounts to 1.7 percent and vegetable food to 98.3.

Animal food.—Animal food was contained in 50 stomachs, all taken in the four months from June to September inclusive, except one, which was taken in November. This stomach contained 20 percent of some insect food, apparently flies. In one stomach taken in September beetles formed 1 percent of the contents. No other trace of a beetle was found. A small wasp or bee was identified in one stomach, also taken in September. It amounted to 2 percent of the contents and was the only hymenopterous insect found. Caterpillars amount to only a small fraction of 1 percent, and were contained in 2 stomachs, one taken in June and the other in July.

The great bulk of the animal food was made up of Hemiptera in the form of plant lice. These were found in 46 stomachs distributed through the four months from June to September inclusive, though more than half of them were taken in August. One stomach was entirely filled with these insects, and in another 300 were counted. Considered in relation to the food of the year, however, they amount to only 1.6 percent. Many of these plant lice are of the kind commonly called woolly aphids, because their bodies are covered with a white cottony appearing substance, really a white wax, which exudes from the body of the insect. While the destruction of this small number of insects may seem insignificant, yet the goldfinch is one of the forces that keep within reasonable bounds the immense swarms of these prolific and pestiferous creatures. By far the greater number of these aphids were found in the crops and not in the stomachs; but as many of the latter were not accompanied by the crops, possibly the goldfinch consumes many more of these insects than is shown above. Then, too, aphids are very fragile, and by the time they reached the stomach many of them were probably too much reduced to be identified.

Vegetable food.—The vegetable food may be divided into 4 categories: Fruit, grain, weeds, and miscellaneous matter. Fruit was found in 7 stomachs, all taken in June, July, and August. In one case it was a berry with small seeds, which have not yet been identified; in the others it could be classed only as fruit pulp. Altogether it amounts to three-tenths of 1 percent of the year's food. A single kernel of wheat was found in 1 stomach taken in December. Weed seed is the standard food of this goldfinch. It aggregates over 96 percent of the year's diet, and in January and March nothing else is eaten. The month of least consumption, August, shows over 86 percent, and in every other month it is above 94. While several species are eaten freely, the chief is the Napa, or bur thistle (*Centaurea melitensis*), which was found in 243 of the 476 stomachs, and would seem to be the staff of life of the goldfinch. It is a small hard seed covered with an apparently siliceous shell, with a hook at one end and a bunch of stiff bristles at the other.[a] Generally the bird skillfully removes this shell and swallows only the starchy pulp. Many kinds of weed seed were found in the 469 stomachs examined, and only 7 did not contain any; 394 contained nothing else.

Other vegetable food, some of it not satisfactorily identified and some of it rubbish, amounts to 1½ percent of the whole. In regard to eating seeds of garden vegetables on seed farms, what was said of the willow goldfinch will apply with equal truth to this species. What seemed to be the petals of flowers were found in a few stomachs, but did not reach a respectable percentage. It does not appear that the green-backed goldfinch requires any other food than weed seed, and of this one or two varieties suffice. The following is a list

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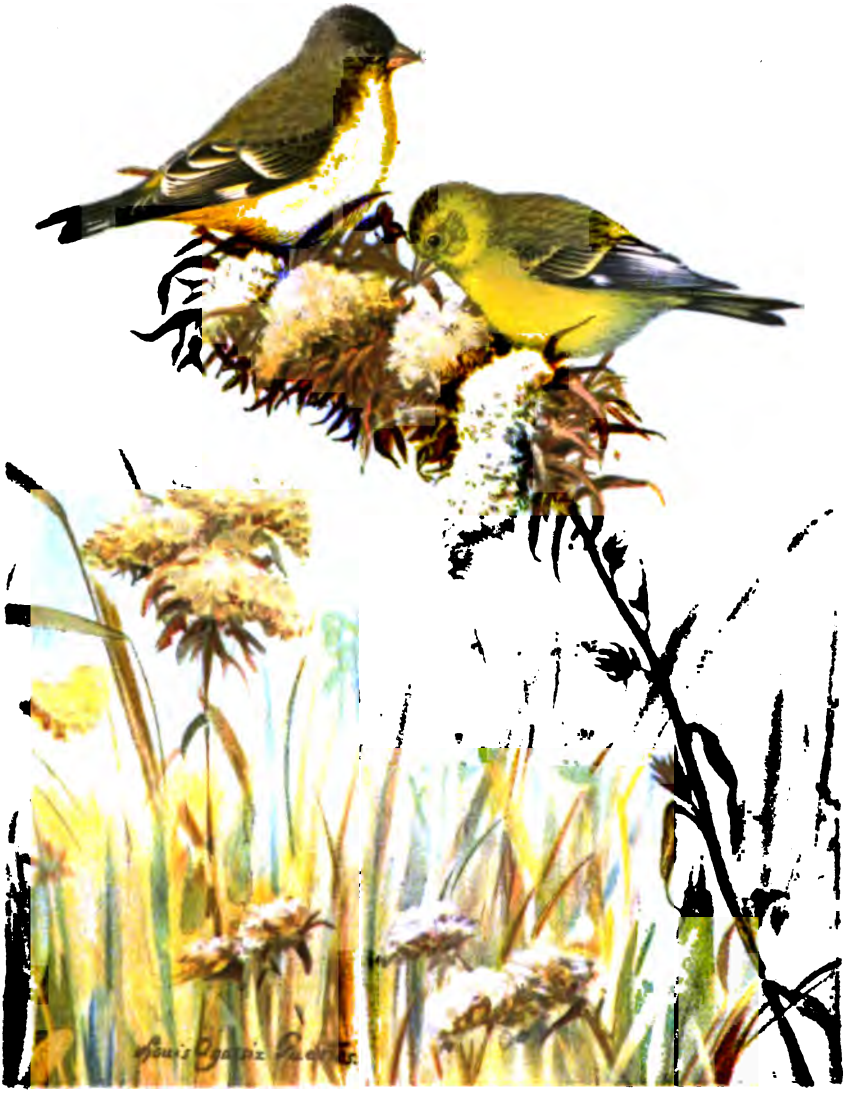
[a] Pl. II, fig. 1, Part I, opp. p. 16.



A Hoen & Co. Lithographers

GREEN-BACKED GOLDFINCH

of the seeds identified and the number of stomachs in which each species was found:

Sunflower (*Helianthus* sp.)	4
Lesser tarweed (*Hemizonia fasciculata*)	1
Tarweed (*Madia sativa*)	23
Mayweed (*Anthemis cotula*)	10
Groundsel (*Senecio vulgaris*)	33
Bur thistle (*Centaurea melitensis*)	243
Black nightshade (*Solanum nigrum*)	1
Turkey mullein (*Eremocarpus setigerus*)	18
Alfilaria (*Erodium cicutarium*)	9
Black mustard (*Brassica nigra*)	1
Miner's lettuce (*Montia perfoliata*)	2
Red maids (*Calandrinia menziesi*)	1
Pigweed (*Amaranthus retroflexus*)	30
Chickweed (*Stellaria media*)	3
Catchfly (*Silene* sp.)	1
Knotweed (*Polygonum* sp.)	2
Sorrel (*Rumex* sp.)	1
Sedge (*Carex* sp.)	6

SUMMARY.

If there are any faults in the food habits of the green-backed goldfinch, the writer does not know them. The little animal food it consumes consists of harmful insects, and practically all of its vegetable food consists of seeds of useless or harmful weeds. This goldfinch should be protected to the fullest extent.

INTERMEDIATE AND NUTTALL SPARROWS.

(*Zonotrichia leucophrys gambeli* and *nuttalli.*)

One or the other of these two subspecies of the white-crowned sparrow is found throughout the year in some part of California, and in winter the intermediate (*gambeli*) is distributed nearly all over the lower parts of the State. These sparrows frequent valleys, brushy hillsides, highways, and cultivated fields. The only complaint against them is that in spring and in winter they eat buds of fruit trees. Buds are usually overabundant, and the loss of some is generally a benefit to the tree; in any event it would require a very thorough disbudding to do much damage.

For the investigation of the bird's food, 516 stomachs were available, taken in every month of the year, though August was represented by only one, and May and July by two each. The first analysis gives 7.4 percent of animal matter to 92.6 of vegetable.

Animal food.—Beetles amount to 1.4 percent of the food. In June they reach nearly 8 percent, but in the other months are unimportant. Practically all of them are harmful. Hymenoptera amount to 1.9 percent. In June they reach over 16 percent, but in the other months rise barely above 1 percent. They were contained in 66 stomachs, of which 48 held ants and 18 contained wasps and bees. Parasitic species were noted in several stomachs.

Hemiptera amount to one-half of 1 percent, and were identified in 11 stomachs, of which 5 contained black olive scales; 2, leafhoppers; 3, stinkbugs; and 1, a tree hopper. Caterpillars are the largest item of animal food and amount to about 3.5 percent. Most of them were eaten in July, when they constituted 37.5 percent of the food, but as only 2 stomachs were collected in that month, this record can not be taken as final.

Vegetable food.—Fruit amounts to 4.5 percent. It was eaten rather irregularly, but most of it from March to July, inclusive. A mere trace was found in stomachs taken in September and October. Elderberries were found in 5 stomachs, blackberries or raspberries in 3, figs in 3, cherries in 2, and in 1 a small berry not positively identified. The cherries were unripe and only partly grown. A little pulp was noticed that might have been from some larger fruit. The great bulk of it was taken in May, June, and July. Grain aggregates 8.6 percent. It was contained in 69 stomachs, as follows: Oats in 56, wheat in 7, barley in 5, and corn in 1. Most of it was eaten in the three winter months, a little in the fall and spring, but practically none in summer. Only 3.5 percent was eaten in March, which would seem to indicate that this bird does not devour the newly sown grain.

Like many other fringilline birds, white-crowned sparrows subsist largely on weed seed. It is eaten freely in every month, and amounts to 74 percent of the yearly food. June is the month of least consumption, 33 percent, but that is the month when the most insects and fruit are eaten. The 1 stomach taken in August was entirely filled with this food, and it was over 90 percent of the contents of those taken in September and October. Of the 516 stomachs only 38, or a little more than 7 percent, contained no weed seed.

Following is a list of the species identified and the number of stomachs in which each was contained:

Sunflower (*Helianthus* sp.)	3
Lesser tarweed (*Hemizonia fasciculata*)	1
Tarweed (*Madia sativa*)	34
Mayweed (*Anthemis cotula*)	75
Bur thistle (*Centaurea melitensis*)	38
Sow thistle (*Sonchus asper*)	4
Prickly lettuce (*Lactuca scariola*)	1
Nightshade (*Solanum nigrum*)	70
Senna (*Cassia* sp.)	7
Lupine (*Lupinus* sp.)	1
Clover (*Trifolium* sp.)	1
Mountain lilac (*Ceanothus* sp.)	1
Poison oak (*Rhus diversiloba*)	12
Alfilaria (*Erodium cicutarium*)	45

Geranium (*Geranium dissectum*)	18
Black mustard (*Brassica nigra*)	3
California poppy (*Eschscholtzia californica*)	1
Miner's lettuce (*Montia perfoliata*)	29
Red maids (*Calandrinia menziesi*)	4
Purslane (*Portulaca oleracea*)	4
Pigweed (*Chenopodium album*)	12
Rough pigweed (*Amaranthus retroflexus*)	208
Spurry (*Spergula arvensis*)	10
Chickweed (*Stellaria media*)	16
Catchfly (*Silene* sp.)	29
Knotweed (*Polygonum* sp.)	76
Sorrel (*Rumex* sp.)	18
Brome grass (*Bromus* sp.)	20
Wild oats (*Avena fatua*)	34
Canary seed (*Phalaris canariensis*)	2
Johnson grass (*Andropogon sorghum*)	1
Sedge (*Carex* sp.)	11
Unidentified	168

As this bird takes a great deal of gravel, the seeds eaten are soon ground into paste, which renders specific identification impossible. Many stomachs were entirely filled with food in this condition, which accounts for the large amount of unidentified material. Very few whole seeds were unidentified. The white-crown is evidently fond of variety, for several stomachs contained as many as 9 different species of seeds. It will be noted also that rough pigweed is the favorite food, while the Arkansas goldfinch preferred bur thistle.

Miscellaneous vegetable matter amounts to 5 per cent, and was found in 30 stomachs. Of these, 11 contained fragments of flowers, probably of fruit trees, for in some cases the embryo fruit could be made out. This is not a very heavy indictment on the score of destroying buds and blossoms. Fibrous vegetable matter of uncertain origin was found in quite a number of stomachs; perhaps it was grass which had been subjected to the grinding action of the stomach.

SUMMARY.

Evidently neither the farmer nor the fruit grower has much to fear from the white-crowned sparrow. On the contrary the bird destroys some insects, all of which are harmful, and a vast number of seeds of noxious weeds. The little fruit it eats is mostly wild, and its grain eating is practically confined to the months when the only grain available is waste or volunteer. In the above record there is little to substantiate the accusation that the bird destroys fruit buds, and probably it is only under very exceptional circumstances that it does any damage in this way.

GOLDEN-CROWNED SPARROW.

(*Zonotrichia coronata.*)

The golden-crowned sparrow arrives in California from the north in September, and departs for its summer residence in April. In winter it spreads over the country, lives wherever food can be obtained, except perhaps in the forest, and may often be seen in the garden among the fruit trees or in the rose bushes. It is also found in lonely canyons or on the cattle ranges in the hills. In general appearance and in food habits it does not differ essentially from the white-crown. For the determination of its food 184 stomachs were available, taken from October to April, inclusive. The animal food amounts to 0.9 percent, vegetable to 99.1.

Animal food.—The animal food consists of insects, and is pretty well distributed among the various orders. No great quantity was found in any one stomach, and it is eaten so rarely and in such small quantities that the wonder is that it is eaten at all. Singularly enough two worker honeybees were found in one stomach. It is evident that the golden-crown does not search for insects, and takes only those that come in its way.

Vegetable food.—The vegetable food consists of fruit, buds and flowers, grain, and some miscellaneous matter. Fruit can not be a prominent item in the food of this sparrow, owing to the time of year it spends in California. One stomach taken in March contained a little fruit pulp, probably left over from the previous season. Fruit was found also in 2 stomachs taken in October and in 2 taken in November. In one it consisted of elderberries; in one, of grape; in another, it was thought to be apple; while in the fourth, it was unidentifiable. In all, it amounts to a little more than 1 percent of the food. Remains of buds and flowers were found in stomachs taken in every month of the bird's stay in the State, except October and November, when buds are very small. They were found in 56 stomachs; the average for the season is 29.5 percent, and in March it rises to nearly 78 percent. Where this bird is abundant, it may do mischief if it visits the orchards. In the stomach of no other species yet examined has been found so much of this kind of food, which makes it probable that much of the bud and flower eating imputed to the linnet and white-crown is really done by the golden-crown.

Grain was eaten during every month of the bird's stay in the State, but as none of these was a harvest month, little damage was done. March, the sowing month, showed but little more than 5 percent, while over 66 percent was eaten in January. The average for the season was nearly 26 percent. It was found in 23 stomachs, of which 12 contained oats; 6, wheat; 2, barley; 2, corn; and 1, doubtful.

Weed seed amounts to 33 percent of the food and is eaten in every month. It is, however, complementary to the bud and blossom food, the one increasing as the other decreases. Weed seed begins with a percentage of 83 in October, and gradually diminishes, while buds and blossoms appear first in December with 22 percent and increase to their maximum in April.

Below is a list of species identified, showing the number of stomachs in which each was contained:

Tarweed (*Madia sativa*)	11
Mayweed (*Anthemis cotula*)	15
Bur thistle (*Centaurea melitensis*)	18
Nightshade (*Solanum nigrum*)	16
Lupine (*Lupinus* sp.)	1
Clover (*Trifolium* sp.)	2
Turkey mullein (*Eremocarpus setigerus*)	2
Poison oak (*Rhus diversiloba*)	30
Alfilaria (*Erodium cicutarium*)	16
Geranium (*Geranium dissectum*)	16
Mustard (*Brassica nigra*)	1
Rough pigweed (*Amaranthus retroflexus*)	18
Spurry (*Spergula arvensis*)	4
Chickweed (*Stellaria media*)	10
Catchfly (*Silene* sp.)	1
Knotweed (*Polygonum* sp.)	10
Sorrel (*Rumex* sp.)	10
Brome grass (*Bromus* sp.)	11
Sedge (*Carex* sp.)	1
Seeds of conifer	1
Unidentified	39

The last item includes stomachs in which the food was ground to a pulp, rendering identification impossible. Few whole seeds were unidentified. Poison-oak seeds are indicated as found in 30 stomachs, but as a matter of fact not a single seed of that plant was seen in any stomach. The birds ate only the wax which surrounds those seeds and which contains certain woody granules by which it can at once be identified. This species, then, does not aid in the dissemination of these noxious plants.

SUMMARY.

From the foregoing it is evident that the golden-crown during its stay in California does but little service in destroying insects. On the other hand, it does no direct harm to fruit, and little, if any, to grain. It does good by destroying weed seed, although not as much as some other species. By the destruction of buds and blossoms it may do serious harm where it is numerous and visits the orchards.

WESTERN CHIPPING SPARROW.

(*Spizella passerina arizonæ.*)

The western chipping sparrow occurs during the breeding season and early fall over most of the State, and winters sparingly in the southern part. Like its eastern relative it is very domestic, and often builds its nests in gardens and orchards. The bird well merits the name *socialis*, now, unhappily, superseded, and its gentle and confiding ways endear it to all bird lovers. It is one of the most insectivorous of all the sparrows, and is valuable in the garden or about the farm.

For the investigation of this bird's food 96 stomachs were available. They were taken from April to October inclusive, and probably give a fair idea of the food for that part of the year. It is quite likely that the winter food consists largely, if not entirely, of weed seeds, as 4 stomachs taken in the southern part of the State in winter (not included in this investigation) were almost entirely filled with this food. The first division of the stomachs' contents gives 45 percent of animal food and 55 percent of vegetable.

Animal food.—The animal food consists of insects and spiders, with a few bits of eggshell. Beetles were eaten from April to August inclusive, with the maximum of 23 percent in July. In one stomach were the remains of 30 weevils or snout beetles, but so badly crushed and broken that specific identification was impossible. The average monthly percentage is 6.7. Hymenoptera amount to 11.8 percent. They are represented mostly by ants, with which several stomachs were entirely filled. The greatest quantity were eaten in June, when they aggregated 67.5 percent, or more than four-fifths of the animal food for the month. In the other months they were taken rather irregularly and in small quantities.

Hemiptera are eaten to the average extent of 7.5 percent. They appear rather irregularly, and the greatest consumption is in October, 20 percent. None were found in August or September stomachs, but as only 4 were collected in October, and not many in the two previous months, the record can not be considered as fully reliable. They consist of stinkbugs and leafhoppers, with a few others, of which the most interesting are scales and plant lice. These were each found in 5 stomachs. The scales were the black olive species (*Saissetia oleæ*). Diptera, or flies, do not appear to be favorite food with the chipping sparrow. They were eaten only in the months from April to July inclusive, with the maximum consumption in May, when about 12 percent were taken, or more than half of all. The average per month is only 3 percent.

Caterpillars are evidently the favorite animal food, as they were eaten to an average extent of 14.7 percent, or more than any other insect. They appear in the food during every month of the bird's stay in the north except October, and probably a greater number of stomachs would have shown some in that month. Two stomachs contained pupæ of the codling moth. Only one stomach held grasshoppers, and that was taken in June. Some spiders and eggshells make up nearly 1 percent, and complete the animal food.

Vegetable food.—Grain in the shape of oats was found in 5 stomachs, all collected in July. The total amount for that month is 6 percent, or less than 1 percent for the season. A mere trace of fruit was found in one stomach in June. Weed seed was eaten in every month of the bird's stay, and probably throughout the year. It amounts to over 53 percent of the food, and in September rises to 98 percent. June was the month of least consumption, 9 percent, when insects evidently took its place. The species identified, and the number of stomachs in which each was found, are as follows:

Bur thistle (*Centaurea melitensis*)	2
Nightshade (*Solanum nigrum*)	1
Alfilaria (*Erodium cicutarium*)	37
Miner's lettuce (*Montia perfoliata*)	3
Red maids (*Calindrinia menzeisi*)	2
Rough pigweed (*Amaranthus retroflexus*)	16
Chickweed (*Stellaria media*)	13
Knotweed (*Polygonum* sp.)	1
Timothy (*Phleum pratense*)	1
Meadow grass (*Poa* sp.)	1
Panic grass (*Panicum sanguinale*)	2
Wild oats (*Avena fatua*)	1
Sedge (*Carex* sp.)	2
Unidentified	32

Most of the unidentified seeds were so badly ground up that it was impossible to recognize the species. The greater part probably belonged to species included in the above list. A few very small grass seeds were not further identified.

Feeding the young.—A nest with 4 young of this species, about 6 days old when first observed, was watched at different hours on four days. On the morning of the fifth day a pair of jays carried off the young birds. In the seven hours of observation 119 feedings were noted, or an average of 17 feedings per hour, or four and one-fourth feedings per hour to each nestling. This would give for a day of fourteen hours at least 238 insects destroyed by the brood.

SUMMARY.

In the foregoing discussion of the food of the chipping sparrow it plainly appears that the diet is made up almost exclusively of harmful elements. No useful beetles of any consequence were eaten. Of Hymenoptera, ants, which are either harmful or neutral, predominate, while caterpillars, which are a universal pest, are the favorite animal food. In the vegetable portion of the diet fruit and grain appear as mere traces, while the seeds of noxious weeds make up the bulk of the food. It is not necessary to further eulogize this bird, as it is already welcomed everywhere, as it should be.

WESTERN SNOWBIRD.

(*Junco hyemalis thurberi* and other subspecies.)

Several subspecies of junco occur in California. One form, *J. pinosus*, is a resident of the Monterey Bay region the year round. Another, *thurberi*, is a resident of the State throughout the year, but winters in the valleys and breeds in the mountains. Two others, *oreganus* and *connectens*, occur in winter only, when all the forms spread out and cover a considerable part of the State. It would be better to treat the four races separately, but as many of the stomachs were collected before the races were recognized, their exact identity is unknown. They will be discussed, therefore, as a whole, but what is said of summer food will not apply to *oreganus* and *connectens*.

For this investigation 269 stomachs were available. They were collected in every month except May. March, April, June, and August are poorly represented, but the other months have each a good quota. The first analysis of the food gives 24 percent of animal matter to 76 of vegetable.

Animal food.—Beetles amount to 5 percent, and nearly all were eaten in the months from March to July inclusive, with no record for May. With the exception of two ladybirds (Coccinellidæ) found in 2 stomachs, not a useful species was identified in the whole. Weevils make up the bulk of this item, and a species of scolytid (*Phlœosinus punctatus*) was found in 1 stomach to the extent of 65 percent of its contents. Hymenoptera were represented mostly by ants, with a few wasps, amounting in all to a little more than 2 percent of the food. Caterpillars are apparently the favorite insect food, forming 9.4 percent of the diet. The great bulk were eaten from April to August, and the single stomach taken in August contained 67 percent of them. No special pest was identified. Bugs, grasshoppers, a few other insects, and spiders, make up the remainder of the animal food, 7.3 percent.

Vegetable food.—Seeds of blackberry or raspberry were found in 1 stomach and elderberries in 2. In 14 stomachs taken in November was found fruit pulp averaging over 11 percent of the food of the month. As all fruit except olives is harvested before that time, probably the berries were of no value.

Grain was eaten from October to March inclusive, and amounted to 8 percent for the year. All of it was contained in 30 stomachs, as follows: Oats in 15, wheat in 9, barley in 4, corn in 1, and unidentified in 1. None was taken in a harvest month. The greatest amount, more than 30 percent, was eaten in March, the sowing month, probably much of it from newly sown fields.

Weed seed aggregates 61.8 percent of the food, and was eaten in every month. In September it amounted to nearly 95 percent. A few seeds, mostly of grass, were not identified. The following is a list of identified species and the number of stomachs in which each was contained:

Ragweed (*Ambrosia* sp.)	1
Tarweed (*Madia sativa*)	4
Mayweed (*Anthemis cotula*)	11
Bur thistle (*Centaurea melitensis*)	16
Sow thistle (*Sonchus asper*)	2
Nightshade (*Solanum nigrum*)	11
Lupine (*Lupinus* sp.)	1
Clover (*Trifolium* sp.)	1
Poison oak (*Rhus diversiloba*)	13
Alfilaria (*Erodium cicutarium*)	34
Geranium (*Geranium dissectum*)	4
Mustard (*Brassica nigra*)	3
Miner's lettuce (*Montia perfoliata*)	13
Red maids (*Calandrinia menziesi*)	2
Purslane (*Portulaca oleracea*)	1
Rough pigweed (*Amaranthus retroflexus*)	35
Spurry (*Spergula arvensis*)	9
Chickweed (*Stellaria media*)	42
Catchfly (*Silene* sp.)	21
Knotweed (*Polygonum* sp.)	33
Sorrel (*Rumex* sp.)	26
Wild oats (*Avena fatua*)	8
Timothy (*Phleum pratense*)	1
Panic grass (*Panicum* sp.)	3
Sedge (*Carex* sp.)	14
Coniferous seeds not identified	4
Unidentified	2

Remains of blossoms were found in 1 stomach. The seeds of poison oak were not discovered in the stomachs, but the characteristic granules that are embedded in the waxy coating of the seeds were identified, thus showing that the birds eat this wax without swallowing the seed itself.

SUMMARY.

The insect food of the snowbirds is composed almost entirely of harmful species, of which caterpillars form the largest item. Snowbirds do no damage to fruit or grain. They eat large quantities of weed seeds, thereby rendering a service to agriculture.

WESTERN SONG SPARROW.

(*Melospiza melodia samuelis, heermani,* and other subspecies.)

Song sparrows inhabit not only the greater part of California but all of the United States, except areas where conditions are unsuitable. These birds vary much in habits, as well as in size and coloration. Some forms live along streams bordered by deserts, others in swamps among bulrushes and tules, others in timbered regions, others on rocky barren hillsides, and still others in rich fertile valleys. Each area has its peculiar form, and in fact it is hard to imagine any locality adapted to a land bird of the Temperate Zone which does not fit some form of the song sparrow. With such a variety of habitat, the food of the species necessarily varies considerably. It is impossible to treat here the several forms separately, and the best we can do is to give a general idea of the yearly diet of the species as a whole.

For the investigation of the food of the western song sparrows, 321 stomachs, belonging to 4 or 5 subspecies, were available. They were collected in every month of the year, and fairly represent the whole State. The first analysis separates the food into 21 percent of animal matter and 79 of vegetable. This is less animal food than is eaten by the snowbird, much less than by the chipping sparrow, but much more than by the white-crowned or golden-crowned sparrows.

Animal food.—Animal food, consisting principally of insects, is eaten with a fair degree of regularity through the year. Beginning with a minimum of 3 percent in September, based on the examination of 97 stomachs, it rises gradually to a maximum of over 71 percent in May. Beetles are the largest item, and a greater or less number were eaten every month except December, an omission probably accidental. The average for the year is 6.6 percent. In June, the month of greatest consumption, nearly 29 percent were eaten. With the exception of the remains of tiger beetles (Cicindelidæ) in 3 stomachs and predaceous ground beetles (Carabidæ) in 10, all were of harmful families, the leaf beetles (Chrysomelidæ) and weevils (Rhynchophora) being most prominent.

Hymenoptera (bees, wasps, and ants) were taken very irregularly, and amount to only 3 percent of the food. Ants were found in 22 stomachs, and bees and wasps in 20. Hemiptera, or bugs, form only about 2 percent of the year's food, but 17 percent of the food eaten in May. The black olive scale was found in 2 stomachs and a species not identified in 1. Leafhoppers, spittle insects (Cercopidæ), and a few other forms make up the rest of this item. Diptera (flies) were eaten from May to September inclusive. In May they amount to over 11 per cent, but fall away rapidly, and the aggregate for the year is only 2 percent. A few crane flies (Tipulidæ) and the house fly family (Muscidæ) were the only forms recognized.

Caterpillars, while taken in nearly every month, were eaten very irregularly and to the extent of 4.3 percent only. There was a fair percentage from March to August inclusive, but in other months a trifle or none, except December, in which 5 percent were found. May shows the greatest amount, 14 percent. Grasshoppers are apparently not relished by the song sparrow. A mere trace of these insects was found in a few stomachs collected in February, May, June, and August. They do not form an appreciable percentage of the food. A few insects too finely pulverized for recognition, some spiders, and a few snails make up the remainder of the animal food, 2.5 percent.

Vegetable food.—Evidence of fruit eating was found in 19 stomachs as follows: Seeds of Rubus (blackberries or raspberries) in 9, elderberries in 4, cherries in 2, figs in 1, and fruit pulp or skins in 3. In all it amounts to a trifle more than 2 percent of the food. Grain was absent in all stomachs collected from February to June inclusive, and in November. What was eaten in the other months comes to a little more than 3 percent for the year. The most, 11 percent, was taken in January, but July shows very nearly the same. This last was perhaps gleaned from the field. The varieties are as follows: Barley found in 7 stomachs, oats in 5, and wheat in 2.

The chief food of the song sparrow is weed seed. This amounts to 73 percent of the year's food, and varies from one-fifth to very nearly the whole of each month's diet. In September, when animal food is at its minimum, weed seed reaches a little more than 93 percent. On the other hand, in May, when animal food is at its maximum, weed seed shrinks to a little less than 21 percent. Of the 321 stomachs, 302, or 94 percent, contained weed seed. Of these, 171, or 53 percent of all, were completely filled with it. There were only 19 stomachs that did not contain more or less of this food. The record of this sparrow for eating weed seed is excelled by only four species of California birds—the linnet, the two goldfinches, and the white-crowned sparrow.

Following are the species of weed seeds identified and the number of stomachs in which each was found:

Sunflower (*Helianthus* sp.)	1
Lesser tarweed (*Hemizonia fasciculata*)	1
Tarweed (*Madia sativa*)	9
Mayweed (*Anthemis cotula*)	7
Bur thistle (*Centaurea melitensis*)	36
Sow thistle (*Sonchus asper* and *oleraceus*)	5
Salsify (*Tragopogon porrifolius*)	1
Henbit (*Lamium amplexicaule*)	1
Nightshade (*Solanum nigrum*)	35
Nine bark (*Opulaster opulifolius*)	1
Turkey mullein (*Eremocarpus setigerus*)	1
Poison oak (*Rhus diversiloba*)	3
Alfilaria (*Erodium cicutarium*)	23

Geranium (*Geranium carolinianum*)	1
Mustard (*Brassica nigra*)	1
Miner's lettuce (*Montia perfoliata*)	26
Red maids (*Calandrinia menziesi*)	6
Pigweed (*Chenopodium album*)	1
Rough pigweed (*Amaranthus retroflexus*)	113
Spurry (*Spergula arvensis*)	12
Chickweed (*Stellaria media*)	32
Catchfly (*Silene* sp.)	3
Knotweed (*Polygonum* sp.)	44
Sorrel (*Rumex* sp.)	16
Brome grass (*Bromus* sp.)	4
Wild oats (*Avena fatua*)	14
Timothy (*Phleum pratense*)	1
Canary seed (*Phalaris caroliniana*)	2
Fox tail (*Chaetochloa* sp.)	1
Panic grass (*Panicum sanguinale*)	4
Sedge (*Carex* sp.)	8
Unidentified	97

As usual, the unidentified were either ground to pulp or were seeds of some unknown grass. Evidently the rough pigweed seed (*Amaranthus*) is the favorite. Several stomachs contained nothing else.

SUMMARY.

The economic status of the song sparrow can be summarized in a few words. It eats a comparatively small number of insects, the majority of which are noxious. Fruit and grain are eaten so little as to be of no consequence. Nearly three-fourths of the diet consists of seeds of weeds, most of which are a nuisance. Neither stomach examinations nor field observations furnish evidence that the song sparrow does any harm.

SPOTTED TOWHEE.

(*Pipilo maculatus* and subspecies.)

Under one or other of its several subspecific forms the spotted towhee occurs almost throughout California. As it is resident over much of its range, the good or harm it does continues through the year. It is eminently a bird of the ground and underbrush, and delights in the thickest shrubbery, where it scratches among the dead leaves and twigs. Anyone who approaches the bushes too closely will probably see the bird depart from the opposite side and plunge into another thicket, and in this way one may chase it for hours with no more than an occasional glimpse. This bird is not common about orchard or garden, the chaparral-covered hillsides and canyons being more congenial resorts. It is abundant and widely distributed, and hence is comparatively important from an economic point of view.

For the investigation of the food of this bird 139 stomachs were at hand, collected in every month of the year, though November to May inclusive were not represented as fully as was desirable. The first analysis of the food gives 24 percent of animal matter to 76 of vegetable. Dead leaves, bits of twigs, rotten wood, and other rubbish are very common in the stomachs, and probably are swallowed accidentally with more nutritious morsels.

Animal food.—Beetles are the largest item of animal food, and amount to a little more than 10 percent. Although the larger part of the towhee's living is gleaned from the ground, only 4 stomachs contained the remains of predaceous ground beetles, and 2 others the remains of ladybirds (Coccinellidæ). Weevils were found in 26 stomachs, and in 13 stomachs were the remains of that harmful chrysomalid beetle *Diabrotica soror*. Besides these were fragments of elaterids, buprestids, and cerambycids, all of which in the larval state bore into trees and other plants and do great mischief. Hymenoptera amount to 6 percent of the diet, but are eaten rather irregularly. They are mostly taken in summer, but some appear at all times of the year. They were found in 39 stomachs, of which 25 contained ants, and 14, wasps and bees.

Bugs (Hemiptera) amount to 14 percent; and are distributed among several families; but the only point that merits mention is that the black olive scale was found in 4 stomachs and an unidentified scale in 1. The spotted towhee does not appear to care for grasshoppers. They form only 1.7 percent of the year's food, and are eaten very irregularly. In June they reach a little more than 11 percent, in August they amount to only 6 percent, and few were found in other months. Caterpillars aggregate 3.5 percent of the food. They are eaten rather irregularly, without much regard to season, but the greatest number, 12 percent, were taken in April. A few flies, some other insects, spiders, millepeds, and sowbugs (*Oniscus*) make up about 3 percent, the remainder of the animal food. These last are just what the bird would be expected to get by scratching among underbrush.

Vegetable food.—Fruit was eaten in every month from May to November inclusive, with a good percentage in each month. January also shows 11.7 percent, but this was either wild or waste. The average for the year is 17.7 percent. The month of greatest consumption was November, when it amounted to 53.6 percent. All of it was in the shape of fruit pulp, not further identifiable. At that time of year it could have been of no value. Fruit pulp, identified only as such, was found in 23 stomachs. Rubus seeds and pulp (raspberries or blackberries) were found in 23 stomachs; cherries, grapes, and figs in 1 each. Elderberries (*Sambucus glauca*) were found in 6 stomachs, snowberries (*Symphoricarpos racemosus*) in 3, and black twinberries (*Lonicera involucrata*) in 1. The fruit eaten in June and July was almost entirely Rubus fruit, which may have been either wild or cultivated, except in one case, where the seeds of Logan berries were identified. In August and September the fruit eaten was of the larger varieties, like apricots, peaches, and prunes. Later in the year the wild kinds only were taken. The one stomach which contained cherries was collected the last of May. If this bird were as abundant as the linnet, it would do considerable damage to the larger fruits. Under present conditions its depredations probably pass unnoticed.

Grain was eaten from June to December, inclusive, except in November. The amount for the year is 4.7 percent. In August, the month of greatest consumption, 16 percent was taken. It was found in 17 stomachs, of which 10 contained oats; 3, wheat; 3, corn; and 1, barley. As most of this was gleaned after harvest, probably no harm was done.

Weed seed is a standard article of diet with this bird, as with many others. It was found in 93 of the 139 stomachs, and 11 contained nothing else. The average amount for the year is 34.6 percent of the food, and it was found in every month except March; but as only one bird was collected in that month, the exception is probably accidental. January was the month when most was eaten, 62.8 percent, but as some other months stood nearly as high, this has no special significance. Bur thistle seems to be the favorite seed, although the towhee does not show so strong a preference for any weed as some other species exhibit.

Following is a list of species identified and the number of stomachs in which each was found:

Tarweed (*Madia sativa*)	10
Bur thistle (*Centaurea melitensis*)	27
Nightshade (*Solanum nigrum*)	8
Plantain (*Plantago lanceolata*)	1
Senna (*Cassia* sp.)	1
Clover (*Trifolium* sp.)	1
Legumes unidentified	3
Turkey mullein (*Eremocarpos setigerus*)	2
Poison oak (*Rhus diversiloba*)	11
Sumac (*Rhus* sp.)	1
Alfilaria (*Erodium cicutarium*)	11
Mustard (*Brassica nigra*)	1
Miners' lettuce (*Montia perfoliata*)	8
Red maids (*Calandrinia menziesi*)	2
Rough pigweed (*Amaranthus retroflexus*)	11
Chickweed (*Stellaria media*)	8
Knotweed (*Polygonum* sp.)	4
Sorrel (*Rumex* sp.)	5
Wild oats (*Avena fatua*)	9
Sedge (*Carex* sp.)	3
Unidentified	34

Another article of the towhee's food is mast. It is somewhat difficult to distinguish between mast and weed seed when both are ground to a pulp. As divided, however, mast amounts to 15.6 percent of the food. It was found in moderate quantities in stomachs collected from September to February inclusive, and in April also it reached 25 percent, with a trace in June. February was the month in which most was eaten, 46.5 percent. It was found in only 22 stomachs, but 8 of them were completely filled with it. Leaf galls and some unidentified vegetable matter make up a little more than 3 percent, and complete the vegetable food.

SUMMARY.

The spotted towhee is not numerous enough to inflict any great damage, whatever its food habits. Should it become very abundant it might do harm to fruit; but it is so shy that the more the country is cleared and settled the more rare is it likely to become.

CALIFORNIA TOWHEE.

(*Pipilo crissalis* and *senicula.*)

In rural communities on the Pacific coast, the California towhee occupies a place similar to that of the robin in the east. It is quite domestic in habits, and not only is it a familiar sight about orchards and gardens, but it often builds its nest in the shrubbery and vines around the house. Its habits are somewhat more terrestrial than those of the robin, and the fruit it eats is largely that which it finds on the ground. Like the spotted towhee, it forages much under bushes and vines, scratching among the rubbish for food; however, it does not confine itself to such places, but frequents also the open ground, looking for insects and seeds. At such times a pair are almost invariably seen together. The species does not migrate. One or other of its subspecies inhabits most of the valley and foothill country of California west of the Sierra Nevada and San Jacinto mountains.

For the study of the bird's food 399 stomachs were available, collected in every month, with a fair number in each month. The first analysis gives 14.26 percent of animal food to 85.74 of vegetable. The animal food consists of insects and a few spiders, millepeds, and snails. The vegetable part is made up of fruit, grain, weed seeds, and a few miscellaneous substances.

Animal food.—The largest item of the animal food consists of beetles, which amount to 5 percent. The predaceous ground beetles (Carabidæ) were found in 30 stomachs, and were the only useful beetles eaten. Weevils, or snout beetles, were found in 55 stomachs, of which 1 contained 15. Among them was identified one specimen of *Calandra oryza,* the rice weevil, an insect that does much harm to rice. A decidedly harmful species of chrysomelid beetle (*Diabrotica soror*) was found in 43 stomachs. All the other beetles, which belong to several families, are harmful. While beetles were eaten in every month except December, the great bulk were taken from April to July, inclusive. In June they amount to nearly 15 percent, which is the highest for any month.

Hymenoptera amount to less than 2 percent. They consist of ants found in 47 stomachs and bees or wasps in 23 stomachs. Hemiptera, or bugs, are eaten to a small extent in nearly every month, but do not reach a high percentage in any. The maximum, 6 percent, occurs in March. The average is barely 1 percent for the year. The favorite kinds appear to be leafhoppers, shield bugs, and stinkbugs. Black olive scales were found in 11 stomachs, and a second species, not identified, in 1.

Caterpillars are eaten sparingly in every month. The amount for the year is 3.26 percent, and the maximum consumption, 8.5 percent, occurs in March. Pupæ of the codling moth were found in 2 stomachs. Grasshoppers and crickets amount to 2.5 percent for the year. In July they aggregate nearly 16 percent, which is a remarkably small amount for such a confirmed ground feeder as the towhee. They are eaten rather irregularly from April to October inclusive, with a trace in January. The remainder of the animal food, consisting of a few flies and other insects, spiders, millipeds, and snails, amounts to a little more than one-half of 1 percent.

The following insects were identified in the stomachs:

COLEOPTERA.

Bradycellus rupestris.
Philonthus albionicus.
Tachyporus californicus.
Hypnoides ornatus.
Ptilinus ruficornis.
Aphodius rugifrons.
Aphodius rubidus.
Diabrotica soror.
Blapstinus pulverulentus.
Blapstinus rufipes.
Notoxus alamedæ.
Calandra oryza.

HEMIPTERA.

Saissetia oleæ.

LEPIDOPTERA.

Carpocapsa pomonella.

Vegetable food.—Fruit was eaten in every month from April to October inclusive, and also in December and January. The total for the year is 4.4 percent of the food. The greatest quantity was taken in June, when it amounted to 9.3 percent. Fruit, consisting of pulp and skins without seeds, was contained in 24 stomachs, Rubus fruits (blackberries or raspberries) in 28, cherries in 4, strawberries in 3, and elderberries in 41. Thus the towhee does no great damage to fruit—in fact, the fruit eaten is mostly wild or that which has been injured and left on the ground.

Grain is eaten regularly in every month and in a fair quantity. It amounts for the year to about 28 percent. The most is taken in fall and winter, though the variation is not very marked. August appears to be the month of greatest consumption, but it is doubtful if this would hold true if more stomachs were examined, as October is about the same. June shows a higher percentage than either May or July, which indicates that some of the grain was gathered from the harvest field. Oats were the favorite kind, found in 140 stomachs. Barley was contained in 34, wheat in 16, and corn in 6. Sixteen stomachs were filled with grain alone, most of them with oats, but several with barley and one with corn.

The towhee is another of those species whose standard food is weed seed. It amounts to nearly 51 percent of the yearly diet. Even in June, the month of least consumption, it amounts to one-fifth of the food, while in December it reaches its maximum, 83.6 percent; but a good percentage is eaten in every month, no matter what other food is at hand.

Weed seed was found in 304 stomachs, and 46 contained nothing else. The quantity of this seed consumed by the towhees of California in one year must be enormous. The following are the species identified and the number of stomachs in which each was found:

Sunflower (*Helianthus* sp.)	1
Lesser tarweed (*Hemizonia fasciculata*)	7
Tarweed (*Madia sativa*)	34
Mayweed (*Anthemis cotula*)	6
Milk thistle (*Silybum marianum*)	1
Bur thistle (*Centaurea melitensis*)	39
Burweed (*Amsinckia tesselata*)	4
Nightshade (*Solanum nigrum*)	22
Plantain (*Plantago lanceolata*)	1
Lupine (*Lupinus* sp.)	19
Clover (*Trifolium* sp.)	9
Legumes not further identified	39
Turkey mullein (*Eremocarpos setigerus*)	5
Poison oak (*Rhus diversiloba*)	7
Alfilaria (*Erodium cicutarium*)	55
Geranium (*Geranium dissectum*)	1
Yellow sorrel (*Oxalis corniculata*)	4
Mustard (*Brassica nigra*)	10
Poppy (*Eschscholtzia californica*)	2
Miners' lettuce (*Montia perfoliata*)	26
Red maids (*Calandrinia menziesi*)	4
Pigweed (*Chenopodium album*)	1
Rough pigweed (*Amaranthus retroflexus*)	77
Spurry (*Spergula arvensis*)	2
Chickweed (*Stellaria media*)	27
Catchfly (*Silene* sp.)	5
Knotweed (*Polygonum* sp.)	40
Sorrel (*Rumex acetosella*)	10
Brome grass (*Bromus* sp.)	5
Wild oats (*Avena fatua*)	33
Canary seed (*Phalaris canariensis*)	1
Panic grass (*Panicum* sp.)	1
Unidentified	77

Mast, in the shape of acorn meat, was taken to a slight extent. It reaches about one-half of 1 percent for the year. Vegetable rubbish aggregates 2.4 percent.

Food of young.—Among the 399 stomachs already discussed were those of 16 nestlings. They consisted of one brood of 3 about 2 days old; 3 broods, 9 in all, about 10 days old; and one brood of 4, probably 2 weeks old. The three youngest ones had been fed entirely on animal food, mostly grasshoppers, caterpillars, and spiders, with a few bugs. The 9 next in age had been fed animal matter to an average extent of 92 percent, to 8 percent of vegetable food. The animal food differs in proportions, not in constituents, from that taken by the adults. It is composed mainly of grasshoppers and caterpillars, with a few beetles, bugs, and wasps. The vegetable matter contains a little fruit, but the greater part is made up of wads or tangles of vegetable fibers. In one stomach the tangle consisted of horsehair. The same fact has been noted with the young of other species. The four that were 2 weeks old had been fed 95 percent of animal food and 5 percent of vegetable matter. The animal part is not so largely composed of grasshoppers, caterpillars, and spiders as with the younger birds, but beetles, wasps, and ants are more prominent. All of them contained remains of the beetle *Diabrotica soror* to an average extent of nearly 33 percent. Every one of these 4 stomachs contained a tangle of vegetable fibers, which constituted the whole of the vegetable food except one seed.

Some observations were made upon the feeding of nestlings of this species. It was found that the young are not fed as often as those of some other species, but probably get more at each feeding. The parent visiting the nest to feed the young gives food to all of them before leaving, and evidently regurgitates it from the gullet for this purpose. As the result of watching two nests for several hours, the maximum number of feedings in one hour was found to be 6, but from 2 to 4 was nearer the average. During the intervals between the feedings the parents could be seen hopping about on the ground and in the shrubbery searching for food, with which they appeared to gorge themselves, for caterpillars and other insects could be seen projecting from their bills. Both parents took part in the feeding, though when the nestlings were very young one bird stayed near or upon the nest until the other came, when they exchanged work.

SUMMARY.

The little animal food the California towhee eats is mostly of an injurious character. While eminently a ground feeder, it does not eat more of the predaceous ground beetles (Carabidæ) than other birds less terrestrial in their habits, and no more than a due proportion. In its vegetable food it probably does little, if any, damage. The amount of fruit eaten is small, and is mostly either damaged or wild. While it eats considerable grain, the great bulk is taken in the fall and winter months. Probably it does not visit the harvest fields much, for although a ground frequenter, it likes the presence of trees and bushes. The service it performs in destroying the seeds of weeds should be sufficient to cover a number of sins, but fortunately there are none serious enough for consideration.

BLACK-HEADED GROSBEAK.

(*Zamelodia melanocephala.*)

During the six months from April to September inclusive, the black-headed grosbeak occurs throughout the State of California, excepting the arid deserts and boreal mountain summits. Like its eastern relative, the rose-breasted grosbeak, it takes readily to orchards and gardens, and is common in agricultural districts. It is a bird of beautiful plumage and sweet song, and is a welcome addition to the attractions of rural life. It often nests in orchard trees, and, as is perfectly natural, gets much of its food there. While this consists mainly of harmful insects, a goodly part of it is fruit. The grosbeak, as its name indicates, has a very powerful bill, and has no difficulty in cutting the skin of the firmest fruit. It feeds upon cherries, apricots, and similar fruits to a considerable extent, but on the other hand it habitually consumes some of the worst insect pests, such as the black olive scale, the 12-spotted diabrotica, and the codling moth. The destruction of this trio alone should entitle the bird to great consideration, but it eats also other destructive insects.

For the laboratory investigation of this bird's food 225 stomachs were accessible. They were collected in the six months from April to September inclusive, a fair number in each, except the last, when only 3 were obtained. These stomachs contained about 57 percent of animal matter to 43 of vegetable. The animal matter is composed of insects and spiders, with a few traces of vertebrates. Insects, such as beetles, scales, and caterpillars, constituted nearly 53 of the 57 percent of animal food.

Animal food.—Of the animal food, beetles are the largest item. They were found in 190 of the 225 stomachs. Of these, predatory ground beetles (Carabidæ) were found in 16 stomachs, and ladybird beetles (Coccinellidæ) in 2. To offset the destruction of these useful insects, the 12-spotted diabrotica, which often does serious injury to fruit trees, was found in 109 stomachs. Many weevils were found, and great numbers of several species of leaf beetles (Chrysomelidæ). To this family belongs the notorious Colorado potato beetle, which at one time seemed likely to ruin the potato industry of the East. The bird which attacked this pest constantly and systematically was the rose-breasted grosbeak, a near relative of the one under consideration. When the potato beetle finds its way into California, as eventually it undoubtedly will, the black-headed grosbeak is the bird most likely to become its active enemy.

Hymenoptera in the form of bees and wasps with a few ants aggregate less than 2 percent. A worker honeybee was found in one stomach. Scale insects amount to 19.83 percent, or practically one-fifth of the whole food. Most of these were the black olive scale (*Saissetia oleæ*), but a few were the plum and prune scales (*Lecanium corni* and *L. pruinosum*). So persistently are scales eaten by this bird that they were found in 142 of the 225 stomachs, or 63 percent of all. While they did not entirely fill any stomach, in 26 they equaled or exceeded 50 percent of the contents. Hemiptera other than scales amount to a trifle over 1 percent.

Caterpillars, pupæ, and a few moths aggregate 7.7 percent. They were mostly eaten in April and May. Pupæ or larvæ of the codling moth were found in 26 stomachs, one stomach containing the remains of 29. Flies, grasshoppers, a few other insects, spiders, and miscellaneous creatures make up somewhat more than 1 percent. Egg-shells were found in several stomachs and the bones of a small fish in one. The animal food of the grosbeak, it will be observed, is nearly all included in the 3 items, beetles, scales, and caterpillars. The other substances appear to be eaten merely as makeshifts.

Following are the insects identified in the stomachs of the grosbeak:

COLEOPTERA.

Platynus variolatus.
Rhizobius ventralis.
Psyllobora taedata.
Megapenthes elegans.
Buprestis fasciata.
Podabrus sp.
Telephorus consors.
Telephorus divisus.
Telephorus sp.
Aphodius rugifrons.
Aphodius sp.
Leptura militaris.
Syneta albida.
Gastroidea cyanea.
Gastroidea sp.
Lina scripta.
Diabrotica soror.
Diabrotica trivittata.
Blapstinus sp.
Deporaus glastinus.
Scythropus californicus.
Dorytomus hispidulus.
Baris sp.
Balaninus sp.

HEMIPTERA.

Saissetia oleæ.
Lecanium pruinosum.
Lecanium corni.

LEPIDOPTERA.

Carpocapsa pomonella.

HYMENOPTERA.

Apis mellifera. ♀

DIPTERA.

Borborus sp.

Vegetable food.—Cultivated fruit amounts to 23 percent of the grosbeak's food for the six months that it stays in the North. None was found in the stomachs taken in April, but in all other months there was a good percentage. Cherries appear to be the favorite fruit, as they were contained in 42 stomachs. Figs were identified in 24 stomachs, blackberries or raspberries in 23, strawberries in 2, apricots in 1, and prunes in 1. Fruit pulp, not further identified, but probably of the larger kinds, was found in 25 stomachs. During cherry season these birds were almost constantly in the trees eating cherries. They do not appear to attack apricots, peaches, and prunes so extensively, but they feed freely on figs later in the season. Blackberries and raspberries are taken whenever possible, but mostly in July and August, after cherries are gone. There is no denying the fact that the grosbeak eats much fruit, and of the best kinds. Wild fruit amounts to something over 5 percent. All of it was eaten in the four months from May to August inclusive, but principally in July and August. The only wild fruit identified was the elderberry (*Sambucus*), which constitutes the bulk of this item, and was found in 26 stomachs.

Seeds of various weeds and some grain constitute 14.7 percent of the food. Oats were found in 9 stomachs and wheat in 7, but the amount was insignificant. The rest of the vegetable food consists of the seeds of more or less troublesome weeds, of which the grosbeak eats a very considerable quantity. The following is a list of the species identified and the number of stomachs in which each was found:

Milk thistle (*Silybum marianum*)	5
Nightshade (*Solanum nigrum*)	1
Bur clover (*Medicago lanceolata*)	2
Poison oak (*Rhus diversiloba*)	1
Sumac (*Rhus sp.*)	1
Alfilaria (*Erodium cicutarium*)	12
Geranium (*Geranium dissectum*)	13
Dwarf mallow (*Malva rotundifolia*)	1
Red maids (*Calandrinia menziesi*)	6
Rough pigweed (*Amaranthus retroflexus*)	3
Chickweed (*Stellaria media*)	13
Knotweed (*Polygonum sp.*)	2
Sorrel (*Rumex acetosella*)	1
Unidentified	24

Food of young.—Among these stomachs are those of 17 nestlings, varying in age from 2 to 8 days. The youngest brood, composed of 3, had been fed entirely on beetles, Hymenoptera, and caterpillars. For convenience, codling moth pupæ may be separated from other caterpillars. The average percentage of each was as follows: Beetles 0.7, Hymenoptera 0.7, caterpillars 92.3, codling moth pupæ 6.3. Note the large percentage of soft food in the shape of caterpillars and pupæ. Broods 2 and 3 were composed of 3 and 4 nestlings respectively, and were probably about 1 day older than brood 1. Their stomachs were entirely filled with animal food, divided as follows: Beetles 15 percent, caterpillars 55.4 percent, codling moth pupæ 23 percent, scales 2.6 percent, and other insects and spiders 4 percent. These nestlings had been fed with hard beetles to a much greater extent than brood 1, although only 1 day older. Brood 4 was composed of 4 nestlings about a week old. They had been fed on animal matter to the extent of 96 percent to 4 percent of vegetable. The animal food was divided as follows: Beetles 67.6 percent, Hymenoptera 3 percent, caterpillars 2 percent, scales 20.7 percent, and eggshells 2.7 percent. The vegetable matter consisted of hulls of seeds and rubbish. The increase in beetles and other hard food and the decrease in caterpillars in the diet of this brood, as compared with the younger ones, is very marked. Brood 5 contained 3 young, estimated to be 8 days old. These had been fed entirely on animal food, made up of the following elements: Beetles 82 percent, Hymenoptera 10 percent, scales 6.3 percent, larvæ 3.3 percent, insects' eggs 1.7 percent, and spiders 2.7 percent. Another increase in the hard elements of the food over the last is seen here, although the difference in age is presumed to be only a day.

Observations were made upon the feeding of nestling grosbeaks, but the results are not remarkable. A nest of 3 young, estimated to be about 3 days old when first seen, was watched for one-hour periods for several days. The number of feedings varied from 2 to 4 per hour. In this respect the grosbeaks much resemble the California towhee. Like that bird they evidently collect a lot of food and then supply all the nestlings by regurgitation.

SUMMARY.

In summing up the economic status of the black-headed grosbeak, the fact that it eats a considerable quantity of orchard fruit can not be ignored. That this fruit is taken from the ripening crop on the tree is also true. This, however, is the sum total of the grosbeak's sinning. It eats but few useful insects and practically no grain. To offset its fruit eating, it eats habitually and freely the black olive scale, the codling moth, and the 12-spotted diabrotica, three pests of California fruit culture. Comparatively few complaints have been made against this bird by orchardists, and its depredations are not believed to be serious. Should it ever become so plentiful as to cause serious loss, no attempts should be made to destroy the bird, but attention should be directed to devices for protecting the fruit, thus leaving the bird to continue its good work in the destruction of insects. So active an enemy of insect pests as is this grosbeak can not well be spared, especially in view of the possibility of an invasion of the State by the Colorado potato beetle.[a]

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[a] For further information on the food of the grosbeak, see Bull. 32, Biological Survey, Food Habits of Grosbeaks, by W. L. McAtee, 1908.

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H. W. HENSHAW, *Chief*

DISTRIBUTION AND MIGRATION OF NORTH AMERICAN SHOREBIRDS

BY

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WASHINGTON
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey,
Washington, D. C., June 22, 1910.

Sir: I have the honor to transmit herewith, for publication as Bulletin No. 35 of the Biological Survey, a report on the Distribution and Migration of North American Shorebirds, by Wells W. Cooke, assistant, Biological Survey. Many species of shorebirds inhabit the United States or pass through our territory in migration. These birds possess considerable economic importance, and as other wild game like ducks, geese, and swans diminish in numbers their value for food and as a means for sport will increase. Large numbers are annually killed, and unless prompt measures are taken adequately to protect them some of the larger and more important kinds are likely to become extinct, especially in the region east of the Mississippi River. A knowledge of the summer and winter abodes of the several species and of the routes they take in migration is essential to intelligent legislation in their behalf, and, accordingly, all the known facts in regard to this part of their life history are here brought together.

Respectfully,

H. W. Henshaw,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.
Introduction.. 5
Distribution.. 6
Migration.. 10
North American shorebirds.. 14
  Red phalarope.. 14
  Northern phalarope.. 16
  Wilson phalarope.. 18
  Avocet.. 19
  Black-necked stilt.. 20
  European woodcock.. 21
  Woodcock.. 21
  European snipe.. 23
  Wilson snipe.. 23
  Great snipe.. 26
  Dowitcher.. 26
  Long-billed dowitcher.. 28
  Stilt sandpiper.. 29
  Knot.. 31
  Purple sandpiper.. 33
  Aleutian sandpiper.. 34
  Pribilof sandpiper.. 34
  Sharp-tailed sandpiper.. 34
  Pectoral sandpiper.. 35
  White-rumped sandpiper.. 37
  Baird sandpiper.. 39
  Least sandpiper.. 41
  Long-toed stint.. 42
  Cooper sandpiper.. 43
  Dunlin.. 43
  Red-backed sandpiper.. 43
  Curlew sandpiper.. 45
  Spoon-bill sandpiper.. 45
  Semipalmated sandpiper.. 46
  Western sandpiper.. 47
  Sanderling.. 48
  Marbled godwit.. 50
  Pacific godwit.. 51
  Hudsonian godwit.. 52
  Black-tailed godwit.. 53
  Green-shank.. 54
  Common red-shank.. 54
  Greater yellow-legs.. 54
  Yellow-legs.. 56
  Solitary sandpiper.. 58
  Western solitary sandpiper.. 60
  Green sandpiper.. 61
  Wood sandpiper.. 61
  Willet.. 61

North American shorebirds—Continued.

Page.
Western willet 62
Wandering tattler 63
Ruff 64
Upland plover 64
Buff-breasted sandpiper 67
Spotted sandpiper 69
Long-billed curlew 71
Hudsonian curlew 72
Eskimo curlew 74
European curlew 76
Whimbrel 77
Bristle-thighed curlew 77
Lapwing 77
Dotterel 77
Black-bellied plover 78
European golden plover 79
Golden plover 80
Pacific golden plover 85
Killdeer 85
Santo Domingo killdeer 88
Semipalmated plover 88
Ringed plover 90
Little ringed plover 90
Piping plover 91
Snowy plover 92
Mongolian plover 93
Azara ring plover 93
Wilson plover 93
Rufous-naped plover 94
Mountain plover 94
Surf bird 95
Turnstone 96
Ruddy turnstone 97
Black turnstone 98
European oyster-catcher 99
Oyster-catcher 99
Frazar oyster-catcher 99
Black oyster-catcher 100
Stone curlew 100
Mexican jacana 100
Black jacana 100
Colombian jacana 100

LIST OF ILLUSTRATIONS.

Page.
Plate I. Yellow-legs (*Totanus flavipes*) 56
II. Upland plover (*Bartramia longicauda*) 64
III. Spotted sandpiper (*Actitis macularia*) 68
IV. Killdeer (*Oxyechus vociferus*) 84

DISTRIBUTION AND MIGRATION OF NORTH AMERICAN SHOREBIRDS.

INTRODUCTION.

Shorebirds form a valuable national resource, and it is the plain duty of the present generation to pass on to posterity this asset undiminished in value. Consistent and intelligent legislation in favor of any group of birds must be founded on extended, accurate information, and must include knowledge of the breeding and distribution of the birds—where they spend the summer, whither they retire in winter, and when and by what routes they migrate. The present bulletin supplies this needed information so far as it is now available.

Consideration of our shorebirds (*Limicolæ*) from an economic point of view is recent. The early settlers found ducks, geese, and swans swarming in certain sections of the United States, and grouse and turkeys very abundant. The size and toothsomeness of these birds made them important objects of pursuit for food, while the shorebirds were considered unworthy of notice. As the great flocks of ducks and geese along the Atlantic coast diminished in numbers, the attention of gunners, especially of market hunters, was turned to the shorebirds, then in countless numbers. A generation of constant harassment spring and fall has almost exterminated some of the larger species and has very greatly reduced even the smaller ones. The time has come when this indiscriminate slaughter must cease if the present remnant of the shorebirds is to be preserved.

The range of our shorebirds extends from ocean to ocean, so that all parts of the United States have an interest in their preservation. These birds feed naturally in the open country or along the open shore, where they are easily found and are constantly subject to attack. The prairies of the Mississippi Valley in past years formed the great highway of spring migration. Flock followed flock in almost endless succession across the prairies of Kansas, Nebraska, and the Dakotas, over a region that of late years has passed under the plow. As this area becomes more densely populated the shorebirds, once so abundant, are likely to become extinct unless active measures are taken for their preservation.

There are excellent reasons for protecting and preserving the shorebirds. Some of them, especially the several kinds of plovers, perform important service in destroying noxious insects. The flesh of many of them, even of the smaller kinds, has a high food value, and some of the larger species—the upland, golden, and black-bellied plovers, and the curlews—were in the times of their abundance important articles of diet. Their pursuit for sport, when they are shot over decoys, demands a high degree of skill, and is a favorite pastime of many hunters. Nor should the esthetic side of the question be ignored. The graceful forms and motions of these birds as they feed at the edge of the breakers are an interesting sight to thousands of seashore visitors. The silencing of their melodious calls would be a loss to every lover of nature. Finally, it may be said in their favor that not one of the shorebirds ever does any harm, while many have proved of great value to agriculture. Their accounts have only a credit side.

The shorebirds are among the most widely distributed of all birds. As far to the northward as man has found land shorebirds breed, while in winter they visit the tropical and Antarctic shores. The distances traversed in their migrations probably average greater than those of any other family, and the shorebirds probably exceed all others in the number of miles traveled in a single flight.

DISTRIBUTION.

The shorebirds are represented in North America by 76 species and 9 subspecies, a total of 85 recognized forms; but the following 7 of these do not range so far north as the United States:

Southern Species not Ranging North to the United States.

Rufous-naped plover (*Ochthodromus wilsonius rufinuchus*).
Stone curlew (*Œdicnemus bistriatus*).
Colombian jacana (*Parra melanopygia*).
Black jacana (*Parra nigra*).
Cayenne lapwing (*Hoploxypterus cayanus*).
Azara ring plover (*Ægialitis collaris*).
Santo Domingo killdeer (*Oxyechus vociferus torquatus*).

There remain 78 species and subspecies that occur in the United States and northward, but 5 of these are found only in Greenland, as follows:

European Species Occurring in North America only in Greenland.

European snipe (*Gallinago gallinago*).
Black-tailed godwit (*Limosa limosa*).
Whimbrel (*Numenius phæopus*).
Golden plover (*Charadrius apricarius*).
Oyster-catcher (*Hæmatopus ostralegus*).

Fifteen other species from the Eastern Hemisphere are known as stragglers on the mainland of North America:

Stragglers in North America from the Eastern Hemisphere.

European woodcock (*Scolopax rusticola*).
Great snipe (*Gallinago media*).
Long-toed stint (*Pisobia damacensis*).
Dunlin (*Pelidna alpina*).
Curlew sandpiper (*Erolia ferruginea*).
Spoon-bill sandpiper (*Eurynorhynchus pygmeus*).
Green-shank (*Glottis nebularia*).
Red-shank (*Totanus totanus*).
Green sandpiper (*Helodromas ocrophus*).
Wood sandpiper (*Rhyacophilus glareola*).
Ruff (*Pavoncella pugnax*).
Lapwing (*Vanellus vanellus*).
Dotterel (*Eudromias morinellus*).
Little ringed plover (*Ægialitis dubia*).
Mongolian plover (*Ægialitis mongola*).

Deducting these, there are 58 species of shorebirds that belong to the regular avifauna of North America north of Mexico. Not all of these, however, occur in the United States. The sharp-tailed sandpiper is a regular migrant through Alaska, but is not found elsewhere in North America. The Pacific godwit, bristle-thighed curlew, and Pacific golden plover breed in Alaska and migrate thence to Asia and the Pacific islands. The ringed plover breeds in northeastern North America and migrates to Europe. The turnstone breeds in both northeastern and northwestern Arctic America, but migrates to Europe, Asia, and the Pacific islands without coming regularly to the United States; while the Aleutian and the Pribilof sandpipers both breed and winter in Alaska. A further deduction of these 8 species leaves 50 species which regularly visit the United States during some part of the year.

The shorebirds as a group are far northern breeders. The majority of them breed in the region of the Arctic Circle, and several range north to the known limits of land. The majority do not breed so far south as the United States, and hence are known there only as migrants, or in the winter season.

Species that Breed Wholly North of the United States.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Dowitcher (*Macrorhamphus griseus*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Stilt sandpiper (*Micropalama himantopus*).
Knot (*Tringa canutus*).
Purple sandpiper (*Arquatella maritima*).
Aleutian sandpiper (*Arquatella maritima couesi*).
Pribilof sandpiper (*Arquatella maritima ptilocnemis*).
Sharp-tailed sandpiper (*Pisobia aurita*).
Pectoral sandpiper (*Pisobia maculata*).
White-rumped sandpiper (*Pisobia fuscicollis*).
Baird sandpiper (*Pisobia bairdi*).
Least sandpiper (*Pisobia minutilla*).
Red-backed sandpiper (*Pelidna alpina sakhalina*).
Semipalmated sandpiper (*Ereunetes pusillus*).
Western sandpiper (*Ereunetes mauri*).
Sanderling (*Calidris leucophæa*).
Pacific godwit (*Limosa lapponica baueri*).
Hudsonian godwit (*Limosa hæmastica*).
Greater yellow-legs (*Totanus melanoleucus*).
Yellow-legs (*Totanus flavipes*).
Wandering tattler (*Heteractitis incanus*).
Buff-breasted sandpiper (*Tryngites subruficollis*).
Hudsonian curlew (*Numenius hudsonicus*).
Eskimo curlew (*Numenius borealis*).
Bristle-thighed curlew (*Numenius tahitiensis*).
Black-bellied plover (*Squatarola squatarola*).
Golden plover (*Charadrius dominicus*).
Pacific golden plover (*Charadrius dominicus fulvus*).
Semipalmated plover (*Ægialitis semipalmata*).
Ringed plover (*Ægialitis hiaticula*).
Surf bird (*Aphriza virgata*).
Turnstone (*Arenaria interpres*).
Ruddy turnstone (*Arenaria interpres morinella*).
Black turnstone (*Arenaria melanocephala*).

Species that Breed in Both the United States and Canada.

Wilson phalarope (*Steganopus tricolor*).
Avocet (*Recurvirostra americana*).
Woodcock (*Philohela minor*).
Wilson snipe (*Gallinago delicata*).
Marbled godwit (*Limosa fedoa*).
Solitary sandpiper (*Helodromas solitarius*).
Western solitary sandpiper (*Helodromas salitarius cinnamomeus*).
Willet (*Catoptrophorus semipalmatus*).
Western willet (*Catoptrophorus semipalmatus inornatus*).
Upland plover (*Bartramia longicauda*).
Spotted sandpiper (*Actitis macularia*).
Long-billed curlew (*Numenius americanus*).
Killdeer (*Oxyechus vociferus*).
Piping plover (*Ægialitis meloda*).
Black oyster-catcher (*Hæmatopus bachmani*).

Species that do not Breed North of the United States, with Northern Limit of Breeding Range.

Black-necked stilt (*Himantopus mexicanus*), Oregon.
Snowy plover (*Ægialitis nivosa*), Nevada.
Wilson plover (*Ochthodromus wilsonius*), Virginia.
Mountain plover (*Podasocys montanus*), Montana.
Oyster-catcher (*Hæmatopus palliatus*), South Carolina.
Frazar oyster-catcher (*Hæmatopus frazari*), California.
Mexican jacana (*Jacana spinosa*), Texas.

Species that Breed Chiefly North of the Arctic Circle, with the Northernmost Latitude at Which the Species has been Observed in the Western Hemisphere.

Red phalarope (*Phalaropus fulicarius*), 82°.
Northern phalarope (*Lobipes lobatus*), 74°.
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*), 71°.
Stilt sandpiper (*Micropalama himantopus*), 69°.
Knot (*Tringa canutus*), 83°.
Purple sandpiper (*Arquatella maritima*), 74°.
Pectoral sandpiper (*Pisobia maculata*), 71°.
White-rumped sandpiper (*Pisobia fuscicollis*), 69°.
Baird sandpiper (*Pisobia bairdi*), 71°.
Least sandpiper (*Pisobia minutilla*), 70°.
Red-backed sandpiper (*Pelidna alpina sakhalina*), 72°.
Semipalmated sandpiper (*Ereunetes pusillus*), 71°.
Sanderling (*Calidris leucophæa*), 82°.
Hudsonian godwit (*Limosa hæmastica*), 69°.
Buff-breasted sandpiper (*Tryngites subruficollis*), 71°.
Hudsonian curlew (*Numenius hudsonicus*), 69°.
Eskimo curlew (*Numenius borealis*), 69°.
Black-bellied plover (*Squatarola squatarola*), 71°.
Golden plover (*Charadrius dominicus*), 77°.
Pacific golden plover (*Charadrius dominicus fulvus*), 65°.
Semipalmated plover (*Ægialitis semipalmata*), 75°.
Ringed plover (*Ægialitis hiaticula*), 78°.
Turnstone (*Arenaria interpres*), 83°.
Ruddy turnstone (*Arenaria interpres morinella*), 74°.

Species that Breed in Both Eastern and Western Hemispheres.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Knot (*Tringa canutus*).
Purple sandpiper (*Arquatella maritima*).
Sanderling (*Calidris leucophæa*).
Pacific godwit (*Limosa lapponica baueri*).
Black-bellied plover (*Squatarola squatarola*).
Pacific golden plover (*Charadrius dominicus fulvus*).
Ringed plover (*Ægialitis hiaticula*).
Turnstone (*Arenaria interpres*).

Species that Winter in the United States and Southward.

Avocet (*Recurvirostra americana*).
Black-necked stilt (*Himantopus mexicanus*).
Woodcock (*Philohela minor*).
Wilson snipe (*Gallinago delicata*).
Dowitcher (*Macrorhamphus griseus*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Purple sandpiper (*Arquatella maritima*).
Least sandpiper (*Pisobia minutilla*).
Red-backed sandpiper (*Pelidna alpina sakhalina*).
Semipalmated sandpiper (*Ereunetes pusillus*.)
Western sandpiper (*Ereunetes mauri*).
Sanderling (*Calidris leucophæa*).
Marbled godwit (*Limosa fedoa*).
Greater yellow-legs (*Totanus melanoleucus*.)
Yellow-legs (*Totanus flavipes*).
Western willet (*Catoptrophorus semipalmatus inornatus*).
Spotted sandpiper (*Actitis macularia*).
Long-billed curlew (*Numenius americanus*).
Black-bellied plover (*Squatarola squatarola*).
Killdeer (*Oxyechus vociferus*).
Semipalmated plover (*Ægialitis semipalmata*).
Piping plover (*Ægialitis meloda*).
Snowy plover (*Ægialitis nivosa*).
Wilson plover (*Ochthodromus wilsonius*).
Mountain plover (*Podasocys montanus*).
Ruddy turnstone (*Arenaria interpres morinella*).
Black turnstone (*Arenaria melanocephala*).
Oyster-catcher (*Hæmatopus palliatus*).
Frazar oyster-catcher (*Hæmatopus frazari*).
Black oyster-catcher (*Hæmatopus bachmani*).
Mexican jacana (*Jacana spinosa*).

SPECIES THAT DO NOT WINTER NORTH OF SOUTH AMERICA.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Wilson phalarope (*Steganopus tricolor*).
Stilt sandpiper (*Micropalama himantopus*).
Knot (*Tringa canutus*).
Pectoral sandpiper (*Pisobia maculata*).
White-rumped sandpiper (*Pisobia fuscicollis*).
Baird sandpiper (*Pisobia bairdi*).
Hudsonian godwit (*Limosa hæmastica*).
Solitary sandpiper (*Helodromas solitarius*).
Western solitary sandpiper (*Helodromas solitarius cinnamomeus*).
Upland plover (*Bartramia longicauda*).
Buff-breasted sandpiper (*Tryngites subruficollis*).
Eskimo curlew (*Numenius borealis*).
Golden plover (*Charadrius dominicus*).
Surf bird (*Aphriza virgata*).

The three following species winter in the West Indies or Central America and southward, but are not found at this season in the United States: Willet (*Catoptrophorus semipalmatus*), wandering tattler (*Heteractitis incanus*), and Hudsonian curlew (*Numenius hudsonicus*). The purple sandpiper (*Arquatella maritima*) remains in winter as far north as Greenland and does not range south of the United States; while the Aleutian sandpiper (*Arquatella maritima couesi*) and the Pribilof sandpiper (*Arquatella maritima ptilocnemis*) do not occur in winter south of Alaska.

SPECIES THAT RANGE SOUTH IN WINTER TO SOUTH AMERICA, WITH THE SOUTHERN LIMIT OF THE WINTER RANGE.

Red phalarope (*Phalaropus fulicarius*), Falkland Islands.
Northern phalarope (*Lobipes lobatus*), Peru and probably farther.
Wilson phalarope (*Steganopus tricolor*), Falkland Islands.
Black-necked stilt (*Himantopus mexicanus*), Peru.
Dowitcher (*Macrorhamphus griseus*), Brazil.
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*), probably Peru.
Stilt sandpiper (*Micropalama himantopus*), Uruguay.
Knot (*Tringa canutus*), Tierra del Fuego.
Pectoral sandpiper (*Pisobia maculata*), Argentina.
White-rumped sandpiper (*Pisobia fuscicollis*), Tierra del Fuego.
Baird sandpiper (*Pisobia bairdi*), Chile.
Least sandpiper (*Pisobia minutilla*), Chile.
Semipalmated sandpiper (*Ereunetes pusillus*), Patagonia.
Western sandpiper (*Ereunetes mauri*), Venezuela.
Sanderling (*Calidris leucophæa*), Argentina.
Hudsonian godwit (*Limosa hæmastica*), Strait of Magellan.
Greater yellow-legs (*Totanus melanoleucus*), Strait of Magellan.
Yellow-legs (*Totanus flavipes*), Strait of Magellan.
Solitary sandpiper (*Helodromas solitarius*), Argentina.
Western solitary sandpiper (*Helodromas solitarius cinnamomeus*), not known.
Willet (*Catoptrophorus semipalmatus*), Peru.
Upland plover (*Bartramia longicauda*), Argentina.
Buff-breasted sandpiper (*Tryngites subruficollis*), Argentina.
Spotted sandpiper (*Actitis macularia*), Peru.
Hudsonian curlew (*Numenius hudsonicus*), Chile.
Eskimo curlew (*Numenius borealis*), Patagonia.
Black-bellied plover (*Squatarola squatarola*), Peru.
Golden plover (*Charadrius dominicus*), Argentina.
Semipalmated plover (*Ægialitis semipalmata*), Argentina.
Snowy plover (*Ægialitis nivosa*), Chile.
Surf bird (*Aphriza virgata*), Chile.
Ruddy turnstone (*Arenaria interpres morinella*), Chile.
Oyster-catcher (*Hæmatopus palliatus*), Chile.

Species that Occur in the United States Only as Migrants, Breeding in the Far North and Wintering to the Southward.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Stilt sandpiper (*Micropalama himantopus*).
Knot (*Tringa canutus*).
Pectoral sandpiper (*Pisobia maculata*).
White-rumped sandpiper (*Pisobia fuscicollis*).
Baird sandpiper (*Pisobia bairdi*).
Hudsonian godwit (*Limosa hæmastica*).
Buff-breasted sandpiper (*Tryngites subruficollis*).
Hudsonian curlew (*Numenius hudsonicus*).
Eskimo curlew (*Numenius borealis*).
Golden plover (*Charadrius dominicus*).
Surf bird (*Aphriza virgata*).

SUMMARY.

Species that do not breed north of the United States	7
Species breeding in the United States and Canada	15
Total species breeding in the United States	22
Species breeding wholly north of the United States	36
Species breeding north of and wintering in the United States	15
Species breeding or wintering in the United States	37
Species occuring in the United States as migrants only	13
Total species occurring in the United States	50
Species occurring regularly in Arctic America, but not in the United States	8
Total species occurring regularly in North America north of Mexico	58
European species straggling to Greenland	5
Eastern Hemisphere species straggling to North America	15
Southern species not ranging north to the United States	7
Total species and subspecies in North America	85

MIGRATION.

The shorebirds as a group are among the most wide ranging of migrants. While a few, for example the jacanas, do not migrate at all, most shorebirds migrate more than a thousand miles each season, and many lengthen their journeys to 7,000 miles. The most wonderful feature of their migration is the enormous distance covered in a single flight. As explained in the account of the golden plover, many flocks of plover fly without resting from Nova Scotia to northern South America, a distance of about 2,500 miles. Many individuals of other species perform the same flight, notably the Eskimo curlew, while in the case of the Hudsonian godwit and the upland plover the principal place of departure in fall migration is the coast of the United States north of Virginia, and many of the flocks make stops in the Lesser Antilles on their way to South America.

That the same route is employed by other species is shown by the large number of shorebirds annually visiting the Bermudas. These islands lie about 800 miles off the coast of South Carolina and are in a nearly direct line from southern Nova Scotia to the Lesser Antilles. Years ago, when shorebirds were far more numerous than now, many flocks stopped at the Bermudas in fall migration. The most common species were the pectoral, white-rumped, least, and semipalmated sandpipers, the sanderling, greater yellow-legs, lesser yellow-legs, solitary sandpiper, spotted sandpiper, Hudsonian curlew, semipalmated plover, turnstone, and Wilson snipe. All of these came in sufficient numbers to show that their visits were not accidental, and evidently they had merely paused a few days on their journey to the Lesser Antilles. The killdeer appeared regularly in November and remained through the winter, but since this species scarcely goes north of New England, the individuals wintering on the Bermudas must have visited the islands for the purpose of remaining there through the cold season. Specimens of eleven other species of shorebirds have been taken in the Bermudas. They are less common visitors, and most of these individuals were probably on their way across the ocean to the Lesser Antilles.

This route, however, is not followed by these species in their return in the spring, and there seems to be no evidence as yet that any species of shorebird migrates regularly in the spring across the ocean from the Lesser Antilles to the coast of New England or to eastern Canada. Indeed, shorebirds migrating north in spring through the Lesser Antilles are almost unknown.

Along the Atlantic coast shorebirds are many times more numerous in fall than in spring, while in the Mississippi Valley there is no such pronounced difference of numbers at the two seasons. This fact, taken in connection with the rarity of all species of shorebirds during the spring migration in the West Indies, where they are abundant fall visitors, seems to indicate that in the case of most of the species of shorebirds that migrate south in fall along the Atlantic coast some individuals pass northward in spring by way of the Mississippi Valley. The Eskimo curlew used to follow this route, as still do most of the golden plover. The statement applies also largely to the long-billed dowitcher, stilt, white-rumped, and semipalmated sandpipers, and the lesser yellow-legs. This elliptical migration route is in the case of most species not less than 6,000 miles in its north and south diameter, nor less than 2,000 miles east and west, while the winter home of the white-rumped sandpiper is 9,000 miles from its breeding grounds.

The Hawaiian Islands lie in the Pacific Ocean 2,000 miles from the nearest mainland to the eastward and more than 3,000 miles from the Asiatic coast. The nearest point of Alaska is about 2,000 miles north. Five species of shorebirds that summer in Alaska are found in the Hawaiian Islands during the winter season. They are the turnstone, Pacific golden plover, sanderling, bristle-thighed curlew, and wandering tattler. There is every reason to believe that these Hawaiian birds come from Alaska and that they make the 2,000-mile trip at a single flight. All of these species occur farther south in Oceania, but there seems to be no evidence that any of them use the Hawaiian Islands as a stopping place on the way to a more southern home. Apparently all the birds that fly to the Hawaiian Islands remain there through the winter, while the southern islands of Oceania are populated by individuals that have migrated along the Asiatic coast. It is remarkable that in the case of both the turnstone and the plover the first individuals to arrive on the Hawaiian Islands in the fall are in good condition or even fat, while the curlew and plover that reach the Lesser Antilles by a long flight over the Atlantic Ocean are reported as emaciated.

Shorebirds present some idiosyncrasies of migration that are worthy of mention. The sharp-tailed sandpiper (*Pisobia aurita*) breeds on the northern coast of Siberia, and in fall migration crosses to Alaska and then back again to Asia and by way of Japan and China reaches its winter home in Australia. The most eastern point of its range in Alaska—Norton Sound—is some 500 miles east of its summer home in Siberia. As the species is not known in Alaska in spring, its migration route is probably elliptical, and the northern route in spring is probably across the mainland of Asia.

Some individuals of the marbled godwit (*Limosa fedoa*) have a unique migration route. From their breeding grounds in North Dakota and Saskatchewan some of these birds formerly migrated almost directly east more than a thousand miles to the Atlantic coast, while others traveled a thousand miles due west to the coast of southern Alaska.

Some birds breed in the Western Hemisphere and winter in the Eastern. For example, the Pacific godwit (*Limosa lapponica baueri*) breeds on the western shores of Alaska, whence it passes by way of the Commander Islands, Japan, and China to its winter home in Australia. The bristle-thighed curlew (*Numenius tahitiensis*) follows a somewhat similar route. The wandering tattler (*Heteractitis incanus*) breeds in Alaska and some individuals pass in fall migration to Asia, Hawaii, and Oceania, while others continue down the American coast to the Galapagos.

A long migration route from the eastern side of North America is followed by the ringed plover (*Ægialitis hiaticula*). Some individuals breed in Greenland and still farther west in Ellesmere Land and about Cumberland Sound, whence they pass east and southeast to the European coast and winter from the Mediterranean to southern Africa.

Both these last routes are used by the turnstone (*Arenaria interpres*). The individuals that breed in Greenland and Ellesmere Land migrate southeast to Europe and Africa, while those that breed in Alaska, even as far east as Point Barrow, migrate to the west and southwest to winter in Asia and Oceania.

Another migration route, probably unique, is that taken by the considerable numbers of the mountain plover (*Podasocys montanus*) that winter in the Sacramento Valley and elsewhere in California. The farthest west and north that the species is known to breed is Montana; hence whether the California wintering birds come from Montana or from the more southern districts, they apparently form an exception to the general rule that North American birds do not winter farther west than they breed.

Though many of the shorebirds breeding in North America winter in the southern part of South America, none of them breed in their winter home. Special attention needs to be called to this fact, because nearly a dozen species of this family—among which may be noted particularly the greater and lesser yellow-legs and the white-rumped sandpiper—have been reported as breeding near the southern end of South America. In no case has it been claimed that the eggs have been found, and all the records are based on the finding of young not fully grown or in most cases simply from the presence of individuals during the usual breeding season of local species. This latter reason is not even presumptive of breeding. Nearly a hundred species of North American birds escape the winter of the Northern Hemisphere by visiting South America, and they remain there through what is the breeding season of the resident species, but do not themselves undertake any household cares. It may be stated positively that none of the Limicolæ that breed north of the equator breed also in the southern part of their range.

Species that are Regular Migrants Spring and Fall on the Atlantic and the Pacific Coasts and in the Interior.

American avocet (*Recurvirostra americana*).
Wilson snipe (*Gallinago delicata*).
Least sandpiper (*Pisobia minutilla*).
Greater yellow-legs (*Totanus melanoleucus*).
Spotted sandpiper (*Actitis macularia*).
Black-bellied plover (*Squatarola squatarola*).
Killdeer (*Oxyechus vociferus*).
Semipalmated plover (*Ægialitis semipalmata*).

Species that are Regular Migrants Spring and Fall on both the Atlantic and the Pacific Coasts, but are Rare or Wanting in the Interior.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Red-backed sandpiper (*Pelidna alpina sakhalina*).
Sanderling (*Calidris leucophæa*).
Hudsonian curlew (*Numenius hudsonicus*).
Ruddy turnstone (*Arenaria interpres morinella*).

Species that are Regular Migrants Spring and Fall on the Atlantic Coast and in the Interior, but are Rare or Wanting on the Pacific Coast.

Woodcock (*Philohela minor*).
Knot (*Tringa canutus*).
Pectoral sandpiper (*Pisobia maculata*).
Solitary sandpiper (*Helodromas solitarius*).
Piping plover (*Ægialitis meloda*).

Species that are Regular Migrants Spring and Fall on the Pacific Coast and in the Interior, but are Rare or Wanting on the Atlantic Coast.

Wilson phalarope (*Steganopus tricolor*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Western willet (*Catoptrophorus semipalmatus inornatus*).
Long-billed curlew (*Numenius americanus*).

Species that Occur in Migration Principally on the Pacific Coast.

Black-necked stilt (*Himantopus mexicanus*).
Western sandpiper (*Ereunetes mauri*).
Western solitary sandpiper (*Helodromas solitarius cinnamomeus*).
Wandering tattler (*Heteractitis incanus*).
Snowy plover (*Ægialitis nivosa*).
Surf bird (*Aphriza virgata*).
Black turnstone (*Arenaria melanocephala*).
Black oyster-catcher (*Hæmatopus bachmani*).

Western Species that Come East in Migration to the Atlantic Coast.

Wilson phalarope (*Steganopus tricolor*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Baird sandpiper (*Pisobia bairdi*).
Western sandpiper (*Ereunetes mauri*).

The data on the breeding and wintering of the shorebirds has been collated from all available printed sources, from the manuscript reports of the field naturalists of the Biological Survey, and from the specimens and catalogues of the United States National Museum. The dates of migration have been obtained principally from the migration schedules sent in by the several hundred observers in the United States and Canada, who for a quarter of a century have contributed to the Biological Survey spring and fall reports of their observations. It is a pleasure to testify to the earnest and conscientious efforts these observers have put forth for the solving of some of the phases of Nature's great migration problem and to return thanks to them for their painstaking labors.

NORTH AMERICAN SHOREBIRDS.

Red Phalarope. *Phalaropus fulicarius* (Linn.).

Breeding range.—The summer home of the red phalarope is circumpolar, and the species is known at this season from the whole northern coast and islands of America, Europe, and Asia, except a few regions, the most notable of which is the eastern coast of Greenland. It has been known to breed south to St. Michael, Alaska, 63° N. (Nelson); to Cape Eskimo, west coast of Hudson Bay, 61° N. (Preble); Hudson Strait, 62° N. (Turner); and to the south end of Greenland, 60° N. (Schalow). It has been noted north to 83° N., north of Spitzbergen (Sverdrup); 82° 30′ N. on Ellesmere Island (Feilden); Melville Island, 74° 30′ N. (Parry); and Point Barrow, 71° N. (Murdoch). It is especially abundant as a breeder along the coast and islands of Arctic America.

Winter range.—The Old World winter home of the species extends south to Morocco, India, China, and New Zealand. Knowledge of the winter range in the Western Hemisphere is very meager. The species has been noted in the extreme southern parts of South America on the Falkland Islands (Schalow), and Juan Fernandez (Sharpe); in November, when it may have been migrating, at Coquimbo, northern Chile (Salvin); on December 5 in Chile, locality not designated (Sharpe); specimens are recorded from Argentina and Colombia (Sharpe), without date or locality. The lack of records for this species is remarkable. There seem to be no records whatever for the West Indies nor for the whole of middle America, except the western coast of Lower California, where the species is ordinarily a rare spring and fall migrant, but occasionally is seen in large flocks (Kaeding). Stragglers have been noted at Mount Pleasant, S. C., December 4, 1900 (Wayne); on the coast of northern Lower California, February 21 (Belding); and occasionally in winter at San Diego, Calif. (McGregor).

Migration range.—Enormous flocks of the red phalarope have been noted on the Atlantic Ocean during both spring and fall migration. These flocks are common and regular around Newfoundland; become less common southward off the coast of Maine; and are rare off the coast of Massachusetts, except when driven inshore by storms. The red phalarope swims as lightly and easily as any duck, and during migration has been noted repeatedly gathering its food from the surface of the ocean. Indeed, it seems to have an aversion to land except during the breeding season. The migration route by which these flocks of red phalarope pass south after they leave Massachusetts is unknown. The species is known only as a rare straggler on the coast of the United States south of Long Island, and as already remarked is not recorded from the West Indies nor from the east coast of South America north of Argentina. On the Pacific coast the species is an abundant breeder in Alaska, and the flocks pass along the coast of California both spring and fall, after which they can no longer be traced. A few occur on the coast of Lower California, and the species is a rare straggler to the coast of Chile. The principal winter home of the thousands of birds reared each season in arctic America remains yet to be determined.

The red phalarope occurs as a rare straggler in the interior of the United States in migration, and has been recorded from Illinois, Indiana, Ohio, Michigan, Ontario, Wisconsin, Minnesota, Kansas, and Wyoming. The first and only record for Colorado is that of a single specimen taken by Edward A. Preble, of the Biological Survey, July 25, 1895, near Loveland.

Spring migration.—Some early flocks appeared off the coast of North Carolina the first week in April, 1896 (Thayer); most of the migration on the coast of Massachusetts occurs during May, especially May 20–30; the first appeared June 2, 1820, on Melville Island, latitude 74° N. (Parry), and June 3, 1852 (Armstrong), near the same locality; on June 18, 1883, the first was seen at Fort Conger, Ellesmere Island, latitude 81° 40′ N. (Greely); and on June 20, 1876, the species appeared 1 degree farther north on the same island (Feilden). Even considering the 1st of May as the time of arrival on the Massachusetts coast, which is probably too early, there are left only fifty days for the 3,000-mile trip from Massachusetts to Ellesmere Island, an average rate of migration of 60 miles per day, which is exceeded by very few species. In spring migration the red phalarope has been noted on the coast of California from April 3 to June 3 (Kaeding), and reached Point Barrow, Alaska, June 4, 1882, and May 30, 1883 (Murdoch).

Eggs have been taken in Greenland June 3–28 (Hagerup); near Fort Anderson June 27 (MacFarlane); and at St. Michael June 8 (Nelson).

Fall migration.—The earliest fall birds are seen on the coast of California during July (Loomis); the larger flocks begin to appear late in August and pass south for the next three months. The last seen at Point Barrow, in 1882, was on October 10 (Murdoch). The species was abundant off the coast of Massachusetts August 4, 1877 (Kumlien); and has been noted on Long Island to the third week of November (Braislin).

Northern Phalarope. *Lobipes lobatus* (Linn.).

Breeding range.—The northern phalarope breeds in the arctic region of both hemispheres, but does not go quite so far north as the last species. It ranges from the Chuckchi Peninsula of Siberia eastward across the whole arctic coast of America to the eastern coast of Greenland. It breeds north to Upernivik, Greenland, 73° N. (Kumlien); Melville Island, 74° N. (Walker); Point Barrow, Alaska, 71° N. (Murdoch); and Wrangel Island, Siberia, 72° N. (Nelson). The main breeding ground lies farther south on the mainland of North America, especially in northern Mackenzie and western Alaska. It breeds south to Ungava Bay, about 59° N. (Turner); near Rupert House, Ontario (Drexler); to near York Factory, Keewatin, 57° N. (Preble); Fort Anderson, Mackenzie, 68° 35′ N. (MacFarlane); Pastolik, in the delta of the Yukon, Alaska, 63° N. (Dall and Bannister); and to Kiska Island, near the west end of the Aleutians, 52° N. (Dall). In the Eastern Hemisphere it is an abundant breeder from the limit of tree growth to the Arctic coast, and in eastern Siberia occasionally south to latitude 55°.

Winter range.—The winter home of the great flocks of northern phalaropes that breed in arctic America is unknown. The European and Siberian birds winter on the coast of Europe and south to Persia, India, China, and the Malay Archipelago. For the whole of the Atlantic coast of both North and South America there is not a single winter record. A solitary bird was noted at Tumbez, Peru, January 28 (Taczanowski); and the species has been recorded from Chorillos, Peru, without date (Berlepsch and Stolzmann). These are the only certain records for the whole of South America. This lack of winter land records suggests the possibility that both this species and the red phalarope spend the winter in midocean feeding and sleeping on the surface of the water.

Migration range.—The northern phalarope comes south along the eastern coast of North America, and is seen commonly as far south as Nova Scotia. The flocks seem normally to strike south from Nova Scotia into midocean, but occasionally they are driven westward by storms and appear on the New England coast, sometimes by thousands. The birds are not rare south to Long Island, but farther south can be considered hardly more than stragglers, though recorded to South Carolina (Loomis).

The northern phalarope is a regular though not common migrant throughout the interior of the United States, and has been recorded from almost every State north of the Ohio River and south to Kansas (Goss) and New Mexico (Henry). There is no record as yet for any of the Gulf States. The species is a common migrant on the Pacific coast of America, and is sometimes abundant south to the coast of central California. Farther south it is less common, though recorded from San Jose, Lower California, in the fall (Brewster), and from the west coast of Mexico in the spring (Nelson). The few noted at Duenas, Guatemala, in August and September (Salvin), and those at Desamparados, Costa Rica (Salvin and Godman), complete the record for Central America.

Spring migration.—The northern phalarope was noted in the Bermudas March 21–22, 1848 (Hurdis), and March 8, 1852 (Reid). This is almost two months earlier than the species usually appears on the New England and Long Island coasts. Six years' observations at Montauk Point Light gives May 13 as the mean date of spring arrival—earliest, April 30, 1898 (Scott). Almost all the dates for the coast of Massachusetts are in May. The species arrives at the northern limit of its range about the middle of June. Some late records on the Atlantic coast are: Near Charleston, S. C., June 3, 1903 (Wayne); Montauk Point, New York, June 3, 1894 (Scott); on the coast of Maine to the middle of June (Job).

The northern phalarope was common at Sihuatanejo, on the western coast of Mexico, April 9, 1903 (Nelson); it usually appears on the coast of California in early May, reaches the mouth of the Yukon the middle of May, and was noted in the Kowak Valley, Alaska, May 22, 1899 (Grinnell); Point Barrow, June 11, 1883 (Murdoch), and June 15, 1898 (Stone); Walker Bay, Prince Albert Land, June 15, 1852 (Greely). Individuals are occasionally seen on the California coast in summer, but these are nonbreeders.

Eggs have been taken near Rupert House, Ontario, June 18, 1860 (Drexler); near Fort Anderson, June 16, 1862 (MacFarlane); at Kiska Island, Aleutians, June 30, 1873 (Dall); St. Michael, Alaska, June 1–20 (Nelson); and Kowak Valley, Alaska, June 28, 1898 (Grinnell).

Fall migration.—Returning migrants appear on the coast of central California less than six weeks after the northbound flocks disappear, and are common by the end of July. The great flocks pass during August, are less common in September, and cease in October—latest, Monterey, October 24, 1896 (Loomis). The average date of fall arrival at Montauk Point, New York, is August 28—earliest, August 5, 1893, latest, October 22, 1888 (Scott). The last one noted at Point Barrow was seen August 17, 1898 (Stone), and the species usually disappears from the mouth of the Yukon the last of September.

Records of migration in the interior of North America are not numerous. In southwestern Saskatchewan the fall migration opened July 13, 1906, with the arrival of a large flock, and a few days later the birds were abundant. This is only four weeks later than the departure of the northbound migrants, which had been seen in the vicinity in 1905 from May 29 to June 15, and the following year as late as June 14 (Bent). A remarkable flight of northern phalaropes occurred near Terry, Mont., in 1899; during the last ten days of May the birds were exceedingly abundant (Cameron).

Wilson Phalarope. *Steganopus tricolor* Vieill.

Breeding range.—The northern Mississippi Valley and the adjacent parts of Canada form the principal summer home of the Wilson phalarope. It breeds regularly as far east as northwestern Indiana (Lake County; Butler) and the islands near Green Bay shore (Schoenebeck). Macoun records that a pair nested at Dunnville, Ontario, near the northeastern shore of Lake Erie. Thence the breeding range extends west through central Iowa (Newton; Preston) and northern Colorado (Fort Collins; Cooke) to central California (Lake Tahoe; Bliss; and Las Banos; Mailliard). Instead of penetrating the Arctic regions, as do other phalaropes, this species finds the northern limit of its range in northern Manitoba (Lake Winnipeg; Thompson), central Saskatchewan (Osler; Colt), central Alberta (Edmonton; Macoun), northern Washington (Cheney; Johnson), and probably southern British Columbia.

Winter range.—The few winter records for this species come from South America—from central Chile (Philippi) and central Argentina (Durnford) south to Patagonia (Durnford) and the Falkland Island (Sclater). There is a single record in fall migration for western Brazil (Pelzeln). and one in May for central Peru (Berlepsch and Stolzmann). Three specimens were collected January 19, 1890, at Corpus Christi, Tex. (Sennett), but these were apparently laggards, for the species is not usually seen in Texas after September.

Migration range.—During the fall migration individuals wander eastward to the Atlantic coast and have been noted from New Jersey to Montreal. There is also one May record for Massachusetts (Baird, Brewer, and Ridgway) and one June record for Maine (Smith). The species seems to be unknown on the Atlantic coast between New Jersey and Argentina. The principal summer home is in western North America, and most of the species migrate south through Mexico and along both Mexican coasts, and then apparently cross directly to the west central coast of South America, since the species is unknown in Central America east of Guatemala and in South America north of Peru.

Spring migration.—The Wilson phalarope arrives in central Kansas on the average April 27, earliest April 23, 1885 (Kellogg); northern

Colorado about May 1; Chicago, Ill., average May 6; Heron Lake, Minn., average May 11, earliest May 8, 1889 (Miller); Hallock, Minn., average May 14, earliest May 9, 1896 (Peabody); Reaburn, Manitoba, average May 21, earliest May 16, 1898 (Wemyss); Osler, Saskatchewan, May 19, 1893 (Colt).

The earliest eggs in northern Iowa are deposited about May 20 (Anderson); eggs nearly hatched have been found in southern Saskatchewan June 7 (Macoun): young just hatching, June 16, at Lake Tahoe, California (Bliss), and at the same stage June 22, at Fort Klamath, Oregon (Merrill).

Fall migration.—The Wilson phalarope moves southward so early that most have left the breeding grounds soon after the middle of August; the last seen at Lanesboro, Minn., in 1885, was on September 13 (Hvoslef). The species continues passing through Mexico until October (Ferrari-Perez).

Avocet. *Recurvirostra americana* Gmel.

Breeding range.—The central western United States is the principal summer home of the avocet, but its breeding range extends north to central Wisconsin (Green Bay; Kumlien), southern Manitoba (Souris; Thompson), southern Saskatchewan (Osler; Colt), southern Mackenzie (Fort Rae; Ross), and central Oregon (Haines; Haines). It breeds south to northern Iowa (Hawarden; Anderson), northwestern Texas (Oberholser), southeastern New Mexico (Carlsbad; Bailey), and to Orange County, Calif. (Santa Ana; Grinnell). Many years ago this species was not rare on the Atlantic coast, and a few are known to have nested at Egg Harbor, N. J. (Giraud). At the present time it is a very rare visitor to any part of the Atlantic coast, and has scarcely been seen in New Jersey for the last twenty years. At various times in the past the avocet has been recorded along the coast from Florida (Cory) to southern New Brunswick (Chamberlain); one of the latest records is that of three birds seen September 13, 1896, at Ipswich Neck, Mass. (Kennard), and a single bird taken October 8, 1903, at St. Marys, Ga. (Arnow). The species occurs in the interior east of the Mississippi River, as a rare visitor from Louisiana (Audubon) to Ontario (Fleming), but is known to breed only in Wisconsin.

Winter range.—The avocet winters abundantly on the coast of Texas (Merrill) and in southern California (Newberry); sparingly through Chihuahua and Lower California and thence south to Guatemala (Salvin). During migration it has wandered a few times to Cuba (Gundlach), Jamaica (Gosse), and twice even to Barbados (Feilden).

Spring migration.—The month of April is the time of most activity in spring migration. By the latter part of this month the birds have reached South Dakota, and their average date of arrival at Great

Falls, Mont., is April 24 (Williams). They have even been noted at Salt Lake, Utah, as early as March (Baird), and at Ash Meadows, Nev., March 15, 1891 (Fisher). They appeared April 28, 1908, at Okanagan Landing, B. C. (Brooks), May 14, 1892, at Indian Head, Saskatchewan (Macoun), and June 1, 1864, at Fort Resolution, Mackenzie (Preble).

Eggs have been taken at Santa Ana, Calif., as early as May 3 and as late as July 6 (Grinnell); eggs nearly ready to hatch were found at Hawarden, Iowa, June 2, 1900 (Anderson), and at Crane Lake, Saskatchewan, June 9, 1894 (Macoun).

Fall migration.—The southward movement begins so early that by the last of August the first migrants have reached southern Mexico. Individuals have been seen in Nebraska as late as October 27, 1899 (Wolcott), and at Salt Lake, Utah, until a month later. Other late dates are: Cape Elizabeth, Me., November 5, 1878 (Brown); St. Mary Reservoir, Ohio, November 10, 1882 (Dawson); Oberlin, Ohio, November 4, 1907 (Jones); near New Orleans, La., November 12, 1889 (Beyer), and Johnsons Bayou, La., November 26, 1882 (specimen in United States National Museum).

Black-necked Stilt. *Himantopus mexicanus* (Müll.).

Breeding range.—The black-necked stilt is one of the very few shorebirds that breed in the United States and also in the Tropics. The breeding range extends north to Florida (Scott), Louisiana (Beyer), Texas (Merrill), southern Colorado (Henshaw), northern Utah (Allen), and central Oregon (Burns; Preble). More than half a century ago the species nested on Egg Island in Delaware Bay (Turnbull) and as late as 1881 still bred on the coast of South Carolina (Wayne). At the present time the bird is unknown along the whole Atlantic coast north of Florida, though formerly it has been noted locally to northern New England, and in September, 1880, one was seen at Mace Bay, New Brunswick (Chamberlain). In the interior of the United States the species is recorded as a straggler north to Ohio (Langdon), Michigan (Gibbs), Wisconsin (Hoy), Iowa (Rich), and Nebraska (Bruner, Wolcott, and Swenk), but is not known to breed east of the Rocky Mountains north of Texas. The southern limit of the breeding range is not yet well known. The species is a tolerably common resident of the entire West Indies and the whole northern coast of South America. It probably breeds south to central Peru and to the Lower Amazon. It breeds on the islands off the coast of Yucatan (Salvin), and probably on the coast of northeastern Mexico, and south to southern New Mexico (Carlsbad; Bailey) and southern California (Santa Ana; Grinnell). The early explorers of the West recorded it north to the Columbia River, but there are no definite breeding records so far north.

Winter range.—A few winter in southern Florida (Myers; Scott) and on the coasts of Louisiana (Beyer) and Texas (Corpus Christi;

Rhoads), and from southern Sinaloa (Mazatlan; Nelson) and southern Lower California (La Paz; Ridgway), south throughout Central America and the West Indies to central Peru (Santa Lucia; Taczanowski) and the mouth of the Amazon (Sclater and Salvin). The species winters on the Galapagos Islands, and possibly a few remain to breed (Rothschild and Hartert).

Spring migration.—The slight northward migratory movements of this species occur principally in April. Some dates of arrival are: Titusville, Fla., March 11, 1905 (Worthington); Sioux City, Iowa, April 20, 1902 (Rich); Omaha, Nebr., April 20, 1895 (Bruner, Wolcott, and Swenk); Escondido, Calif., April 13, 1896, April 15, 1897 (Hatch); Fresno County, Calif., April 5, 1890 (Eaton); Stockton, Calif., April 13, 1878 (Belding).

Eggs have been taken in southern California from early May to August, and at Salt Lake, Utah, May 22 (Ridgway). At Fort Garland, Colo., the young were just hatched June 21, 1873 (Henshaw).

Fall migration.—The latest dates in Nebraska are in early October, and the species has been noted at Riverdale, Calif., as late as November 19, 1891 (Eaton).

European Woodcock. *Scolopax rusticola* Linn.

The European woodcock is widely distributed in Europe and western Asia. It breeds in northern Europe and northern Asia from beyond the Arctic Circle south to England, Silesia, the Alps, the Himalayas, and the mountains of Japan; also on the Azores, Madeira and Canary islands. It winters from the British Islands, southern Europe and China, to northern Africa, India, and Formosa; it wanders occasionally to eastern North America, and has occurred in Loudoun County, Va., in 1873 (Coues); Chester County, Pa., the end of November, 1886 (Stone); one was taken near Shrewsbury, N. J., December 6, 1859 (Lawrence); one, September, 1889, somewhere in New Jersey (Warren); one, probably of this species, near Newport, R. I. (Baird, Brewer, and Ridgway); one at Chambly, Quebec, November 11, 1882 (Wintle); and one at St. John, Newfoundland, January 9, 1862 (Sclater).

Woodcock. *Philohela minor* (Gmel.).

Breeding range.—The woodcock breeds locally throughout most of its range in the United States, at least south to Jacksonville, Fla. (Brewster), the coast of Louisiana (Beyer), and to Neosho Falls, in southern Kansas (Goss). It will probably be found breeding in some of the bottomlands of eastern Oklahoma. The breeding range extends northward to Pictou, Nova Scotia (McKinlay); Prince Edward Island (Dwight); Chatham, New Brunswick (Baxter); the city of Quebec (Dionne); Bracebridge, Ontario (Macoun); the northern peninsula of Michigan, at Keweenaw Point (Kneeland); extreme northeastern Minnesota, at Elbow Lake (Roberts and Benner); and to Winnipeg, Manitoba (Thompson). The species has wandered north to Newfoundland (Bennett); was noted the end of August, 1879, at York Factory, Keewatin (Bell); and early in August, 1892, on Black River, Saskatchewan (Tyrrell), at latitude 59°—the most northern and also the most western record known. The woodcock has been seen several times in Colorado near Denver (Smith), though its regular range extends only to eastern South Dakota and eastern Kansas.

Winter range.—The woodcock remains in the north until driven away by frost, and the presence of unfrozen ground is the factor that determines the northern boundaries of its range through the winter. The larger part of the species winter in the Gulf States south at least to southern Florida (Myers; Scott) and to southern Texas (Victoria; Mitchell), but in Texas the species is very rare. Few woodcock winter north of latitude 37°, but these few are scattered at favorable localities over a wide area north to Long Island (Giraud), Grafton, Mass. (Mackay), and Vincennes, Ind. (Balmer). Woodcock have been taken several times in December at St. John, New Brunswick, but in each case they proved to be wounded birds (Gilbert). The species has been taken once in the Bermudas, in October, 1842 (Hurdis).

Spring migration.—Not only does the woodcock remain as far north as possible through the winter, but it also pushes northward in spring as soon as frost releases its feeding grounds. Average dates of spring arrival are: Renovo, Pa., March 22, earliest March 13, 1897 (Pierce); Long Island, New York, March 15, earliest March 10, 1898; central Connecticut, average of twelve years March 20, earliest February 24, 1891; eastern Massachusetts, average of eight years March 16, earliest February 22, 1902; southwestern Maine, March 29, earliest March 23, 1905; Halifax, Nova Scotia, March 25, earliest March 10, 1890 (Piers); St. John, New Brunswick, April 3, earliest March 21, 1898 (Banks); Pictou, Nova Scotia, April 12, earliest April 6, 1892 (McKinlay); city of Quebec, average of thirteen years April 17, earliest April 4, 1890 (Dionne); Hillsboro, Iowa, March 17, earliest March 15, 1898 (Savage); Waterloo, Ind., March 11, earliest March 1, 1906 (Link); Oberlin, Ohio, March 21, earliest March 10, 1902 (Jones); Petersburg, Mich., March 17, earliest March 2, 1887 (Trombley); Chicago, Ill., March 26, earliest March 22, 1884 (Wentworth); southern Ontario, April 2, earliest March 26, 1901; Ottawa, Ontario, May 1, earliest April 20, 1890 (White); Quebec, Canada, earliest April 20, 1907 (Dionne).

One of the most pronounced peculiarities of the woodcock is the early date at which it breeds, especially in the Gulf States. Young a few days old were found January 29, 1890, at Covington, La. (Beyer), which requires that the eggs should have been deposited in December. Young a week old were noted at Jacksonville, Fla., March 10, 1877 (Brewster); young at Sourlake, Tex., March 22, 1905 (Gaut); young

a week old at Falls Church, Va., April 18, 1897 (Riley); young just hatched, Norwich, Conn., April 5, 1888 (Rawson); young just hatched, Spearville, Ind., April 13, 1894 (Barnett); young, Oberlin, Ohio, April 19, 1901 (Baird); while eggs have been taken at Caper Island, South Carolina, February 13, 1903 (Wayne); Raleigh, N. C., March 9, 1892 (Brimley); Lower Cedar Point, Maryland, February 25, 1891 (Todd); Fallstown, Md., March 30, 1880 (Kirkwood); Lawrenceville, N. J., March 14, 1889 (Phillips); Rockland, Me., April 26, 1886 (Norris); Wheatland, Ind., March 14, 1882 (Ridgway); and at Vermilion, S. Dak., April 21, 1884 (Agersborg).

The average date of the last woodcock seen at Ottawa, Ontario, is October 19, latest October 23, 1885 (White); average southern Ontario October 21, latest November 6, 1889; usually leave Montreal, Canada, about October 20, but were seen in 1880 to December 16 (Wintle); St. John, New Brunswick, average date of the last seen November 10, latest November 13, 1888 (Banks); Halifax, Nova Scotia, average November 6, latest December 4, 1895 (Piers); southwestern Maine, average of nine years October 22, latest November 23, 1900.

European Snipe. *Gallinago gallinago* (Linn.).

The European snipe is an Old World species breeding in Iceland and throughout northern Europe and Siberia and south to the Alps, southern Russia, and Turkestan. It winters south to northern Africa and to China, Formosa, and the Philippines. It has been taken twice in the Bermudas—December 24 and 29, 1847 (Reid), and three times in Greenland—at Nanortalik, September 6, 1840; at Fiskenaes, October, 1845, both on the west coast of Greenland (Winge); and the third instance was May 29, 1902, at Angmagsalik, on the eastern coast (Helms). A specimen in the British Museum is marked as having come from Canada, but nothing is known of its history.

Wilson Snipe. *Gallinago delicata* (Ord).

Breeding range.—The northern limit of the breeding range of the Wilson snipe extends from Newfoundland (Reeks) and northern Ungava (near Fort Chimo; Turner) to northern Mackenzie (Dease River; Hanbury) and (Fort Anderson; MacFarlane), northern Yukon (La Pierre House; Catalogue United States National Museum), and northwestern Alaska (Kowak River; Grinnell), apparently following closely the limit of trees. Snipe have been noted a few times on the west coast of Greenland (Winge), but there is nothing to prove that they breed in that country. The species breeds south to New Jersey (Trenton; Abbott), northern Indiana (Davis Station; Deane), northern Illinois (Waukegon; Nelson), northern Iowa; (Union Slough, Kossuth County; Anderson), southern Colorado (San Juan County; Drew), northern Nevada (Ridgway), and northern California (Eagle Lake; catalogue egg collection, United States National Museum).

Winter range.—During the winter season some Wilson snipe leave the United States and pass even to northern South America, on the east side to Rio Janeiro (Pelzeln) and on the west to Medellin, Colombia (Sclater and Salvin). A few winter in the Lesser Antilles and many in Jamaica, Cuba, and the Bahamas. The species is common in Mexico and Guatemala, less common in the remainder of Central America. A large part of the species winters in the southern United States, where it was formerly enormously abundant. No exact limit can be given to the northern range in winter. The Wilson snipe can not live where the ground is frozen. Hence the normal northern winter limit would extend from North Carolina through Arkansas to New Mexico and on the Pacific slope to northern California. But many snipe pass the winter much north of the zone of frozen ground, feeding about streams or springs. A few can be found almost every winter on Cape Cod, Massachusetts (Mackay), and a pair were seen during January and February, 1896, as far north even as Wolfville, Nova Scotia (Tufts). From the Mississippi Valley snipe are reported as wintering north to northern Illinois and northern Nebraska (Bruner, Wolcott, and Swenk), while in the Rocky Mountains of Colorado at 8,000-feet near Sweetwater Lake, the presence of warm springs has enabled them to remain the entire winter, though the air temperature fell to —30° F. (Gilmore). They have been known also to winter in northern Montana (Coubeaux) and northern Washington (Snyder). A few snipe appear almost every fall in the Bermuda Islands (Jardine) and sometimes remain through the winter, though usually they are rare in spring.

Spring migration.—A series of nearly twenty years of observations near Alexandria, Va., gives the average date of arrival as March 8, with the earliest February 17, 1897 (Greenwood); the species is most common the last week in March. The average date of arrival in central New Jersey is March 22, earliest March 4, 1877. Some other dates of arrival are: Central Connecticut, average March 23, earliest March 18, 1894; eastern Massachusetts, average April 2, earliest March 21, 1887; southwestern Maine, average April 27, earliest April 14, 1897; Scotch Lake, New Brunswick, earliest April 5, 1907 (Moore); Pictou, Nova Scotia, average April 19, earliest April 11, 1889 (Mackinlay); city of Quebec, average April 23, earliest April 18, 1899 (Dionne).

The movements in the Mississippi Valley are at closely corresponding dates: Central Missouri, average date of arrival March 13, earliest February 17, 1897; Oberlin, Ohio, average March 28, earliest March 19, 1897 (Jones); Chicago, Ill., average April 3, earliest March 17, 1894 (Blackwelder); southern Michigan, average April 3, earliest March 21, 1893; southern Ontario, average April 15, earliest April 1, 1900; Ottawa, Ontario, average April 26, earliest April 12, 1902

(White); Keokuk, Iowa, average March 23, earliest March 13, 1900 (Currier); central Iowa, average March 22, earliest March 11, 1897; southern Wisconsin, average March 30, earliest March 18, 1894; Heron Lake, Minn., average April 5, earliest April 1, 1888 (Miller); central South Dakota, average April 11, earliest April 7, 1890; Aweme, Manitoba, average April 24, earliest April 18, 1896 (Criddle); central Montana, average April 4, earliest March 27, 1894; Rathdrum, Idaho, average April 14, earliest April 8, 1899 (Danby); Okanagan Landing, British Columbia, April 8, 1907 (Brooks); Bulyea, Alberta, April 27, 1904 (Huck); near Fort Providence, Mackenzie, May 2, 1904, and May 1, 1905 (Jones); Fort Simpson, Mackenzie, May 10, 1904 (Preble); Nushagak, Alaska, April 25, 1882 (McKay); Fort Reliance, Yukon, May 2 (Sharpe); Fort Kenai, Alaska, May 5, 1869 (Bischoff); Nulato, Alaska, May 21, 1868 (Dall); Kowak River, Alaska, May 22, 1899 (Grinnell).

In southern Louisiana the average date of departure is April 19, latest April 30, 1887; Raleigh, N. C., average April 26, latest April 28, 1898 (Brimley); central Nebraska, average April 27, latest May 18, 1899; Chicago, Ill., average May 4, latest May 6, 1904 (Dearborn); Oberlin, Ohio, average May 5, latest May 16, 1904 (Jones). Some late dates of the last seen are: San Jose, Costa Rica, February 16, 1890 (Cherrie); Gainesville, Fla., April 15, 1887 (Chapman); Lake Ellis, N. C., May 9, 1906 (Brimley); Washington, D. C., May 4, 1900 (Preble); Bay St. Louis, Miss., May 10, 1902 (Allison); Dallas, Tex., May 1, 1898 (Mayer); Long Pine, Nebr., May 18, 1899 (Bates).

Eggs have been taken at Meadville, Pa., May 13, 1875 (Huidekoper); young about two days old at Trenton, N. J., May 26, 1876 (Abbott); eggs at Branchport, N. Y., May 20, 1896 (Stone); near Waukegan, Ill., April 24, 1896 (Deane); Davis Station, Ind., April 24, 1898 (Deane); Pewaukee, Wis., May 12, 1871 (Goss); Elk River, Minn., May 24, 1884 (Bailey); Minneapolis, Minn., May 14, 1887 (Cantwell); American Fork, Utah, April 29 (Johnson); Fort Klamath, Oreg., May 20, 1883 (Bendire); Yukon River, Alaska, May 28, 1861; Fort Resolution, Mackenzie, May 30, 1864 (Lockhart); Shumagin Islands, Alaska, June, 1895 (Call).

Few of the shorebirds suffer so much from spring shooting as the Wilson snipe. All winter long in the swamps of the southern States it is persecuted by hunters, and as it moves northward it meets a fusillade throughout its whole course. In the central parts of the South shooting is at its height early in March, and just south of the breeding range the bulk of the birds pass early in April.

Fall migration.—July birds south of the breeding grounds are very rare, though they have been noted at Bay St. Louis, Miss., on the very early date of July 29, 1901 (Allison). Some dates of arrival in the fall are: Washington, D. C., August 30, 1894 (Richmond); Frogmore, S. C., September 16, 1885 (Hoxie); northern Florida, average September 26, earliest September 20, 1904 (Williams); southern Louisiana, average August 29, earliest August 25, 1901 (Ballowe); Lincoln, Nebr., August 7, 1900 (Wolcott); San Bernardino River, Sonora, August 19, 1893 (Mearns); San Jose del Cabo, Lower California, August 28, 1887 (Brewster); San Jose, Costa Rica, October 9, 1889 (Cherrie;) Bermudas, September 13 (Reid); Barbados, West Indies, October 11, 1886 (Manning). The hunter near Newport, R. I., secured scarcely a third as many snipe in the fall as in the spring—466 birds in the eight years; earliest July 30, 1870, latest November 14, 1871. The average dates were August 19 to October 27 (Sturtevant).

Some dates of the last seen are: Near Jasper House, Alberta, September 13, 1896 (Loring); Aweme, Manitoba, average October 11, latest November 7, 1907 (Criddle); Lanesboro, Minn., October 31, 1887 (Hvoslef); Keokuk, Iowa, average November 23, latest November 28, 1889 (Currier); Oberlin, Ohio, latest November 22, 1890 (Jones); Ottawa, Ontario, average November 2, latest November 18, 1900 (White); Chicago, Ill., average October 31, latest November 13, 1885 (Holmes); St. John, New Brunswick, November 5, 1889 (Banks); Halifax, Nova Scotia, average November 23, latest December 3, 1894 (Piers); southwestern Maine, average October 21, latest November 8, 1873; Montreal, Canada, average October 30, latest November 13, 1897 (Wintle).

Great Snipe. *Gallinago media* (Latham).

The great snipe is a species of wide distribution in the Eastern Hemisphere. Its breeding range extends from the Scandinavian Peninsula to the Yenisei River of Siberia and from Prussia north to at least 71° north latitude. The winter home is from the Mediterranean to South Africa, and during its migration the species occurs from Great Britain to Persia.

The only record for the Western Hemisphere is that of a skin presented by the Hudson's Bay Company to the British Museum (Sharpe). There is no reason for doubting that the specimen was taken in Canada, but no definite locality can be assigned.

Dowitcher. *Macrorhamphus griseus* (Gmel.).

Breeding range.—The nest and eggs of the dowitcher are not yet known to science, nor has the species been seen in summer at any place where it was probably breeding. The dowitcher is a common migrant on the coasts of New Jersey, New York, Rhode Island, and Massachusetts, and in fall is sometimes very abundant. Farther north its numbers decrease: New Hampshire, tolerably common in fall, no spring records; Maine, tolerably common spring and fall; Quebec, rare migrant; New Brunswick, no records; Nova Scotia, once (Sharpe); Prince Edward Island, once; Ungava, a few in August, 1860, at Henley Harbor (Coues), one June 10, 1863, at Fort Chimo (Turner). North of Ungava, the only record is that of a single accidental occurrence at Fiskenaes, Greenland (Reinhardt). Evidently the dowitcher does not breed in any numbers on the eastern coast of Ungava. The probability that it does not breed there at all is strengthened by the fact that several first class observers, who during the fall migration were in the Gulf of St. Lawrence, did not see any of the birds. It undoubtedly does not go into northeastern Keewatin and the islands of the Province of Franklin, for it is not reported by the various expeditions that have traveled and wintered in those districts, while the specimens taken on the west coast of Hudson Bay belong to the form called *scolopaceus*. The only district left for the breeding ground is the interior of Ungava and the eastern shore of Hudson Bay.

Winter range.—The dowitcher ranges south in winter through the West Indies to the northern coast of South America and to the Amazon River (Sharpe). It remains at least as far north as northern Florida (Worthington) and probably a few as far west on the Gulf coast as Louisiana.

Spring migration.—The first one seen in 1890 at Darien, Ga., was on March 20 (Worthington); the average date of arrival on the southern coast of South Carolina is March 23, earliest March 17, 1885 (Hoxie); central North Carolina, average April 30; Pea and Bodie Islands, North Carolina, April 27, 1905 (Bishop); Long Beach, New Jersey, May 13, 1877 (Scott).

The species is rare west of the Allegheny Mountains, but a few specimens have been reported: Near Chicago, Ill., May 6, 1893 (Woodruff); Toronto, Ontario, not common May 16–31. This last locality seems to be about as far west as the dowitcher occurs regularly, though formerly it probably ranged west to Lake Michigan.

The species is not uncommon on the coast of Florida throughout the summer, but the individuals remaining so far south do not assume the breeding plumage (Scott). Migrants are common in Florida until the last week in May, and on the coast farther north the last leave for the breeding grounds about the first of June (Scott).

Fall migration.—The first migrants appear on the New England coast early in July: Edgartown, Mass., July 4, 1891 (Worth); near Newport, R. I., July 7, 1871 (Sturtevant); Long Beach, New Jersey, July 6, 1877 (Scott); Bone Island, Virginia, July 14, 1880 (Ridgway); Erie, Pa., July 19, 1892 (Todd); Pea and Bodie islands, North Carolina, July 7, 1904 (Bishop); Barbados, West Indies, August 24, 1888 (Feilden). A market hunter near Newport, R. I., shot 1,058 dowitchers during 1867–1874—extreme dates July 7, 1871, and October 20, 1870, and average date of arrival July 17 (Sturtevant). Some dates of the last seen are: Henley Harbor, Ungava, August 21, 1860 (Coues); Montreal, Canada, September 27, 1892 (Wintle); Toronto, Ontario, September 15, 1889 (Fleming).

Long-billed Dowitcher. *Macrorhamphus griseus scolopaceus* (Say).

Breeding range.—The long-billed dowitcher was found as a fairly common breeder in the Anderson River region, Mackenzie (MacFarlane), and breeds thence west along the Arctic coast to Point Barrow, Alaska (Murdoch), though not commonly. It is an abundant breeder at the mouth of the Yukon and on the shores of Norton Sound (Nelson). The species is known from the northern coast of eastern Siberia (Palmen), but as yet has not been found there breeding.

Winter range.—The principal winter home seems to be the shores of the Gulf of Mexico; the species is common as far east as the Gulf coast of Florida (Scott), and a few pass on to Cuba (Lawrence). It is common in Mexico and Guatemala, has been recorded as far south as Costa Rica (Frantzius), and it is probably this form that occurs in Panama (Lawrence).

Some form of the dowitcher occurs on the coast of Ecuador (Salvadori and Festa) and in Peru as far south as Tumbez (Taczanowski), but whether the eastern or western form has not yet been ascertained.

Migration range.—There is a decided easterly fall migration which brings quite a number of long-billed dowitchers to the Atlantic coast of the United States. They are fairly common from Long Island southward, and a few have been taken on the coasts of Rhode Island (Howe and Sturtevant) and Massachusetts (Brewer); and one, August 12, 1891, at Hamilton, Ontario (Fleming). This is the form common in the Mississippi Valley and it is also more common than *griseus*, at least as far east as Ohio. There is one record of its accidental occurrence in Japan (specimen in United States National Museum).

Spring migration.—The long-billed dowitcher is only a straggler in spring on the Atlantic coast, but has been recorded at Washington, D. C., in April, 1884 (Smith and Palmer); Cape May, N. J., May, 1848 (specimen in United States National Museum); while on Long Island, New York, a very early individual was seen March 20 (Lawrence). The species normally reaches northern Indiana and northern Illinois late in April, but one was taken in 1889 at English Lake, Indiana, on the early date of March 11 (Butler). It was enormously abundant along the west shores of Lake Michigan in the early days of the settlement of the country, but of late years has become quite rare. Some dates of arrival farther west are: Fort Brown, Tex., March 27, 1853 (Cassin); Corpus Christi, Tex., March 24, 1889 (Sennett); Lawrence, Kans., April 19, 1873 (Snow); Omaha, Nebr., April 28, 1856 (Cassin); Cheyenne, Wyo., May 3, 1889 (Bond); Fort Kenai, Alaska, May 4, 1869 (Osgood); St. Michael, Alaska, May 18, 1877 (specimen in Sennett collection); Fort Anderson, Mackenzie, May 28, 1865 (MacFarlane); Point Barrow, Alaska, June 19, 1882 (Murdoch).

Eggs were taken at St. Michael, Alaska, May 23, 1880 (Nelson); near Fort Anderson, Mackenzie, June 21, 1864, and June 15, 1865 (MacFarlane); incubating birds were taken at Point Barrow, Alaska, June 28, 1883 (Murdoch).

Fall migration.—Southward-bound migrants were abundant July 31, 1900, on the west shore of Hudson Bay near Fort Churchill (Preble), and this must have been nearly the last of the migration, for none were seen after three days later. By this date the earliest migrants were already far south, as shown by the following dates of arrival: Fort Kenai, Alaska, July 20, 1869 (Osgood); Tulare Lake, Calif., July 8, 1907 (Goldman); Hay Creek, Saskatchewan, July 3, 1906 (Bent); Denver, Colo., July 24, 1873 (Henshaw); Long Island, New York, July 23, 1884 (Dutcher); Pea and Bodie islands, North Carolina, July 7, 1904 (Bishop); San Mateo, Oaxaca, August 12, 1869 (specimen in United States National Museum).

The last were seen at Point Barrow, Alaska, August 17, 1882 (Murdoch), and August 26, 1897 (Stone); Chilliwack, British Columbia, October 29, 1888 (Brooks); Hutton Lake, Wyoming, October 14, 1899 (Knight); Mimbres, Ariz., October 22, 1873 (Henshaw); Souris River, North Dakota, October 1, 1873 (Coues); Lincoln, Nebr., October 20, 1900 (Wolcott); Long Island, New York, October 15, 1884 (Lawrence).

Stilt Sandpiper. *Micropalama himantopus* (Bonap.).

Breeding range.—Information concerning the nesting of the stilt sandpiper is very meager. Several sets of eggs and some young birds were taken at Franklin Bay on the Arctic coast of Mackenzie and one nest was found at Rendezvous Lake, a few miles back from the coast (MacFarlane). A Biological Survey party found young of the year (probably migrants) July 19, 1900, near York Factory, Keewatin, and noted old birds August 12 near Cape Eskimo (Preble). The young were probably hatched somewhere on the Barren Grounds north of York Factory. The record from these regions seems to be the only data so far obtained bearing on the summer home of the species. It is probably safe to say that the breeding range extends along the Arctic coast and the adjoining tundras from near the mouth of the Mackenzie to the tree limit on the western shores of Hudson Bay.

Winter range.—If the winter home is to be determined solely by specimens noted or taken in winter, then it must be said that the winter home of the stilt sandpiper is unknown; for there seem to be only two records of the species anywhere for the months of November, December, and January. One of these is in Mexico (Ferrari-Perez) and the other in Texas (Sennett), and probably both were accidental occurrences. This is one of the rarer sandpipers and the total number of individuals is not great. The species is apparently most common on the Atlantic coast, while a smaller number occur around the Great Lakes and along the eastern edge of the Great Plains in the line leading to the coast of southern Texas. The winter home is therefore to be sought in a southerly direction from the eastern United States. The total records for the whole of Central America are only three, one each in Guatemala (Sclater and Salvin), Nicaragua (Sharpe), and Costa Rica (Zeledon); while the species is recorded as a tolerably common migrant in each of the Greater Antilles and in six islands of the Lesser, but as more common in the Lesser than the Greater Antilles. This latter fact indicates that the principal winter home lies along the Atlantic coast of South America, although records to substantiate this supposition are lacking. The South American records are as follows: Cienega, Colombia, September 13 (Allen); Barbahoyo (Sclater) and Vinces (Salvadori and Festa), Ecuador, each in September; Yquitos, Peru, September and August (Sharpe); Chorillos, Peru (Taczanowski); Nauta, Peru, September, October, March, and April (Sclater and Salvin); Falls of the Madeira, Bolivia, October (Allen); Ilha Grande, Brazil, August (Sharpe), and Matto Grosso, Brazil, October (Pelzeln). There remain the records of specimens taken in Chile (Sharpe) and at Colonia, Uruguay (Sharpe), without date of capture. Present knowledge is therefore summed up by the statement: It winters in South America, south to Chile and Uruguay. One specimen is recorded as taken at Laguna del Rosario, Mexico, in January (Ferrari-Perez), and one at Corpus Christi, Tex., January 19, 1890 (Sennett). As already stated, it is not probable that the stilt sandpiper winters regularly at either of these localities. One taken February 8, 1892, at Manzanillo, Mexico, by Nelson and Goldman of the Biological Survey, may have been an early spring migrant.

Spring migration.—The species is rare in spring migration along the Atlantic coast—indeed, the records are so few that it might be called occasional or even accidental. Some of these records are: Jamaica, April (March); Cuba, April (Gundlach); Sullivan Island, South Carolina, May 11, 1885 (Sennett); Cape Hatteras, North Carolina, May 19, 1898 (Pearson); Long Island, New York, once in May (Chapman), one June 16, 1863 (specimen in United States National Museum); Rhode Island, May 9, 1895 (Howe and Sturtevant). The principal route of spring migration seems to be up the Mississippi Valley and particularly along the direct course from the coast of Texas to Great Slave Lake. Most of the dates of arrival are in May. Some of the more northern are: Indian Head, Saskatchewan, May 18, 1892 (Macoun); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); Cheyenne, Wyo., May 25, 1889 (Bond); Fort Chipewyan Alberta, June 6, 1893 (Russell); the last one noted at Indian Head in 1892 was June 5 (Macoun). Eggs were taken on Anderson River, Mackenzie, June 24, 1863; at Rendezvous Lake, June 27, 1865; and young at Franklin Bay, July 8, 1865 (MacFarlane).

Fall migration.—That fall migration begins as early as possible is evidenced by the presence of the species in Peru and Brazil by August. It is said to arrive on Grenada and Barbados, West Indies, in July, and the earliest records on the Atlantic coast of each of the New England States is in the same month—earliest July 6, 1874, near Newport, R. I. (Sturtevant). As late as 1879 Doctor Brewer stated that it was not yet known to be a regular migrant in this region, while a gunner near Newport, R. I., had listed 279 individuals, shot in 1867–1874, the dates ranging from July 6 to September 19 (Sturtevant), but these records were not published until 1901. Along this part of its course the species is most common in August, and most have departed by early September. Some late dates are: Newfoundland, one September, 1867 (Reeks); St. John, New Brunswick, September 8, 1881 (Chamberlain); Portland, Me., October 13, 1906 (Eastman); Key West, Fla., November 1, 1888 (Scott); Barbados (Feilden), Grenada (Wells), and in Trinidad (Leotaud), a few remain until October. The species has been noted as casual or accidental in Colorado (Thorne), Montana (Coues), British Columbia (Brooks), and Bermuda (Hurdis).

Knot. *Tringa canutus* Linn.

Breeding range.—The summer range of the knot is almost circumpolar, extending from Iceland across the whole of Arctic America and westward to northwestern Siberia. The species has also been taken once in Spitzbergen, but seems in general to be lacking in the Arctic regions north of Europe. There is every reason for believing that the species breeds locally throughout its summer range, but authentic eggs are a great desideratum. Eggs claimed to be positively identified have been collected at four localities: Fort Conger, Grinnell Land, June 9, 1883 (Greely); Disko, Greenland, 1875 (Seebohm); Iceland, June 17, 1898 (Ottosson); Taimyr Peninsula, Siberia, July 6, 1901 (Dresser). These eggs differ so much in size, shape, and coloration that some of them must have been wrongly identified. One of the latest expeditions into the Arctic regions saw young at Goose Fiord, latitude 76° 30′ N., but found no eggs (Sverdrup). The species was found breeding commonly at Igloolik on Melville Peninsula, latitude 69°, in the summer of 1823 (Parry), but none of the many eggs collected were preserved. Three years earlier it had been noted as an abundant breeder on Melville Island (Sabine). At that time the bird was undoubtedly many times more common than now. The Iceland record at 66° latitude is the most southern breeding record, and nestlings have been taken on Grinnell Land at 82° 44′ latitude. These represent the extremes of the breeding range.

Winter range.—The breeding knots of Siberia go south in winter to southern Africa, India, Australia, and New Zealand; those from Arctic America winter in South America, south to Tierra del Fuego, where they were found to be common February, 1895 (Schalow). The species is recorded locally from the coasts of South America, but present data are not sufficient to define the northern limits of the winter range. It is not probable that the knot winters regularly anywhere north of South America, and all records to the contrary, as the three seen in January, 1890, on Muskeget, Mass. (Mackay), must be considered as accidental. On Barbados the species has been noted as late as December 27, 1886 (Manning), but it is there considered to be only a migrant.

Migration range.—The principal migration route is along the Atlantic coast, where the knot is known locally from Florida to Newfoundland, and was formerly quite common. There are notable gaps in the records of this species. It is known locally as a tolerably common migrant throughout the Mississippi Valley east of the ninety-eighth meridian, but apparently these Mississippi Valley birds pass north and a little east to Hudson Bay and thence to the Arctic islands, for the species is unrecorded in the whole interior of Canada west of Hudson Bay, and has not been found even on the Arctic coast of Mackenzie. Southward there is another break in the records, for the specimen taken April 13, 1904, at Rivera, Veracruz (Piper), seems to be the first and only record for Mexico, and there is none for Central America, though the species is moderately common in Texas south to Corpus Christi (Sennett). A few individuals of this species have been seen in migration on the Pacific coast from San Diego, Calif. (Dwight), to Cape Blossom, Alaska (Grinnell).

Spring migration.—The knot arrives on the United States coast in April, but the larger flocks come about the middle of May, and there is no apparent difference in the dates for the whole coast from Florida to Massachusetts. An early date is March 28, at Grand Isle, Louisiana (Beyer, Allison, and Kopman). Near the northern limit of the range some dates of arrival are: Point Barrow, latitude 71° 20′ N., May 30, 1883 (Murdoch); Fort Conger, latitude 81° 40′ N., June 3, 1883 (Greely); Floeberg Beach, latitude 82° 30′ N., June 5, 1876 (Feilden), while far to the southward at Winter Island, latitude 66° N., the first was not noted until June 16, 1822 (Parry), and the next year at Igloolik, a few miles farther north, not until June 14 (Parry).

Fall migration.—Birds from the north arrive on the coast of Massachusetts, on Long Island, and in some seasons, even on the coast of South Carolina (Wayne), by the middle of July; the first was seen at the Olympiades, Wash., July 7, 1905 (Dawson). It seems scarcely possible that these early arrivals can have bred the same year, for earliest dates of young are in July and that at places 2,000 miles or more to the northward. August is the month of principal migration from Maine to South America, and this month also witnesses the departure from the breeding grounds. The last one seen at Floeberg Beach was August 29, 1875 (Feilden); Point Barrow, August 17, 1898 (Stone); Homer, Alaska, August 23, 1901; Winter Island, Melville Peninsula, August 17, 1822 (Greely). During the summer of 1822 the entire stay of the knot on Winter Island was only sixty-two days—one of the shortest nesting periods of any species.

Purple Sandpiper. *Arquatella maritima* (Brünn.).

Breeding range.—The purple sandpiper is principally a bird of the Old World, breeding on the Arctic coast and islands from northwestern Siberia to Iceland. In Greenland it is known on the east coast to Shannon Island, latitude 75° N. (Schalow); and on the west to Thank God Harbor, 81° 40′ N. (Bessels); and probably it breeds at least as far north as latitude 72°. A few were seen at Fort Conger, on Grinnell Land (Greely); several at various times in the fall around Wellington Channel (McCormick); and the species was found common in summer on Banks (Armstrong) and Melville (Ross) islands. The Banks Island record at latitude 74° N., longitude 118° W., marks the extreme northwestern range of the species. To the westward of this it is replaced by *couesi.* The southern limit of the breeding range appears to extend from the southern end of Greenland to the base of the Melville Peninsula, and possibly to the northern shores of Hudson Bay. The species breeds most commonly on the shores of Baffin Bay and Davis Strait.

Winter range.—The purple sandpiper remains the farthest north in winter of any of the shorebirds. It is said to winter sometimes even in southern Greenland (Hagerup), and it is common in winter from Nova Scotia (Sharpe) and New Brunswick(Macoun) southward to the coast of Rhode Island (Howe and Sturtevant). It is a rare but regular winter visitant to Long Island, New York (Dutcher), and has occurred casually thence south to the Bermudas (Reid), Georgia (Sennett), and Florida (Scott). The species is rare anywhere away from the ocean, but has been noted a few times in the vicinity of the Great Lakes.

Spring migration.—Some dates of spring arrival are: Winter Island, June 10, 1822 (Greely); Igloolik, June 14, 1823 (Greely); Cambridge Bay, June 10, 1853 (Greely); Bay of Mercy, June 3, 1852 (Armstrong); Cumberland Sound, June 4, 1878 (Kumlien); Prince of Wales Sound, Ungava, May 27, 1886 (Payne); west coast of Greenland at latitude 72° N., May 29, 1850 (Sutherland). The last usually desert the New England coast in March.

Fall migration.—Occasionally a stray bird appears in September on the New England coast, but the main flocks do not arrive until

November or December. The species is not late in deserting the far North, as evidenced by the following dates of the last ones seen: Thank God Harbor, Greenland, September 11, 1871 (Bessels); Possession Bay, Franklin, September 1, 1818 (Sabine); Wellington Channel, August 28, 1852 (McCormick). At Cumberland Sound a few remained in 1877 until November (Kumlien).

Aleutian Sandpiper. *Arquatella maritima couesi* Ridgw.

The western coast of Alaska and the Aleutian Islands seem to be the principal home of the Aleutian sandpiper. It breeds throughout the whole of the Aleutian Chain, east to the Shumagin Islands (Dall); and also to the westward on the Commander Islands of Asia (Stejneger). It winters on the Aleutians and south along the mainland of Alaska to Sitka (Bischoff). A few of the breeding birds of the Commander Islands remain throughout the winter, but most of them go south as far as the Kurile Islands (Sharpe).

Early in August, when the young are strong of wing, great flocks move north and appear on the west coast of the mainland of Alaska, at least as far north as Kotzebue Sound (Nelson); they occur also inland to Nulato (Dall), and on the Asiatic side at least to Plover Bay (Dall). This northward migration takes them also to the Pribilof Islands (Seale). They remain in this northern part of the range until driven south by the gathering ice; the last leave Norton Sound about the middle of October (Nelson). The earliest records of eggs taken on Bering Island are about the middle of May (Stejneger), and on Unalaska Island the first week in June (Reed).

Pribilof Sandpiper. *Arquatella maritima ptilocnemis* (Coues).

The name Pribilof sandpiper indicates the principal breeding place, but in addition, the species has been found breeding on the islands of St. Lawrence (Nelson), St. Matthew (Elliott), and Hall (Grinnell). It has been taken from July 17 to August 29 on the shores of Norton Sound (McGregor), but there is nothing to indicate that it breeds in the vicinity, and its occurrence there is probably due to a northward migration after the breeding season. The main winter home has not yet been ascertained, and the only winter records to date are those of a few seen in December and January at Portage Bay, near the base of the Alaska Peninsula (Hartlaub). In spring migration the Pribilof sandpiper has been taken April 1–14 at Nushagak, Alaska (Palmer), and in fall migration August 5–14 near Unalaska Island (McGregor). Eggs have been found on the Pribilof Islands from June 19 to July 6 (Prentiss).

Sharp-tailed Sandpiper. *Pisobia aurita* (Latham).

The breeding range of the sharp-tailed sandpiper is not well known. The bird occurs in summer on the north shore of Siberia at Cape Waukarem (Nelson) and the Chuckchi Peninsula (Palmen), and this is probably the principal breeding range. The species winters in Australia and New Zealand and migrates through the Commander Islands, Japan, China, and the Malay Archipelago.

All the records for North America seem to be during the fall migration, at which period—crossing to America on the way to its winter home in Asia—it is fairly common in Alaska on the shores of Norton Sound, and has been noted north to Port Clarence and Hotham Inlet (Nelson). It has been taken a few times on the Pribilof Islands, once on Unalaska Island (Bishop), once on Queen Charlotte Islands (Fannin), and once on Vancouver Island (Brooks). The period of occurrence on the coast of America extends from August 17, when the first was seen on the Pribilof Islands (Grinnell), to October 12, the date of the last seen in Norton Sound (Nelson). The two individuals taken December 27, 1897, on Queen Charlotte Islands (Fannin), were probably stragglers.

Pectoral Sandpiper. *Pisobia maculata* (Vieill.).

Breeding range.—The principal known summer home of the pectoral sandpiper is the coast of northwestern Alaska, from the mouth of the Yukon (Nelson) to Point Barrow (Murdoch). The principal authority on the birds of the Arctic coast east of the Mackenzie is MacFarlane, and he reports that the pectoral sandpiper was rare in the vicinity of Fort Anderson and Franklin Bay, and that he was never able to find the nest. This must have been a local peculiarity of distribution, for Edward A. Preble, of the Biological Survey, found the species abundant in August, 1900, on the barren grounds of the western shore of Hudson Bay; the species is also a common fall migrant on the coast of Ungava (Coues). Undoubtedly all these birds of Keewatin and Ungava nest along the neighboring Arctic coast, where, indeed, the eggs have been taken at Cambridge Bay, Franklin (Collinson).

Winter range.—In winter the species passes to southern South America, at least as far south as Port Desire, Argentina, latitude 40° 30′ S. (Sharpe), and to Antofagasta, Chile, 23° 30′ S. (Philippi). It winters in northern Argentina (Durnford) and as far north as Bolivia (Salvadori) and Peru (Sharpe). Though confined in summer to the seacoast, yet in its migrations it has been noted in Colorado at 13,000 feet (Morrison), and in its South American winter home it is not uncommon in the mountains to 12,000 feet (Sclater).

Migration range.—The pectoral sandpiper has a very pronounced southeastward migration in the fall. How far west the range extends in the Arctics is not yet known, but the bird has been found in late July and August along the northern coast of Siberia as far west as the Taimyr Peninsula (Palmen), and it may sometimes be found on this coast as a breeder. From these far western localities, it starts east and south along the Alaska coast, and a few visit the Pribilof Islands (specimen in United States National Museum) and the eastern

Aleutians (Bishop), but the species is nowhere common on the Pacific coast south of Alaska, showing that most of the Alaskan and Siberian birds cross the Rocky Mountains and migrate southeastward to the winter home. A few pass south along the Pacific coast to the State of Washington (Suckley), and there are two records for California—Mill Valley Junction, September 14, 1896 (Mailliard), and Farallon Islands, September 4, 1884 (specimen in United States National Mueseum). The species reappears again in Lower California, where it is fairly common during fall migration in the Cape Region (Brewster).

The species is well known as a migrant on the west coast of Greenland as far north as Upernivik, latitude 73° (Winge). It is a common migrant throughout the whole of North America east of the Rocky Mountains, and of the West Indies and Central America. It is strangely rare in the northern part of South America, where it seems to be unrecorded in Venezuela and Guiana, and to have been recorded only once from Colombia (Allen). It is common in migration in Ecuador and Brazil.

Spring migration.—The start from the South American winter home must be very early—February, or more likely January—for the average date of arrival at Raleigh, N. C., is March 23; earliest March 21, 1889 (Brimley). Raleigh is full 2,000 miles from the nearest boundary of the winter range, and probably these birds had already traveled over 3,000 miles when they appeared at Raleigh. Some other spring dates are: Beaver, Pa., average April 4, earliest April 1, 1890 (Todd); Erie, Pa., March 23, 1895 (Todd); New Orleans, La., March 7, 1896 (Allison); Hidalgo, Tex., March 16, 1890 (Sennett); St. Louis, Mo., March 17, 1884 (Widmann); Chicago, Ill., average of seven years, March 31, earliest March 27, 1897 (Blackwelder); Terre Haute, Ind., average March 26, earliest March 17, 1887 (Evermann); Ottawa, Ontario, average April 30, earliest April 27, 1894 (White); Keokuk, Iowa, average April 1, earliest March 17, 1893 (Currier); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); Fort Providence, Mackenzie, May 14, 1905 (specimens in collection Biological Survey); Fort Simpson, Mackenzie, May 16, 1904 (Preble); Dawson, Yukon, May 19, 1899 (Cantwell); St. Michael, Alaska, May 24, 1879 (Nelson); Kowak River, Alaska, May 27, 1899 (Grinnell); Point Barrow, Alaska, May 30, 1883 (Murdoch), and May 30, 1898 (Stone). Eggs were secured at Cape Lisburne, Alaska, June 5, 1885 (Woolfe), and at Point Barrow, June 20–July 10, 1883 (Murdoch).

Fall migration.—In common with many other shorebirds, the pectoral sandpiper begins its fall migrations in July; indeed, it is probable that some start southward in June, for the average date of arrival on the coast of Mississippi is July 19, earliest July 15, 1903 (Allison); and at New Orleans, La., earliest July 17, 1895 (Blakemore). These birds were already more than 2,000 miles south of their breeding grounds, and had probably traveled all of this distance, for the pectoral sandpiper is not one of the species whose nonbreeders remain through the summer far south of the nesting grounds. If the fall migration was made at the same speed as the spring migration, about 35 miles per day, these July Gulf coast birds would have had to start on the return trip the middle of May, or earlier than they reach their breeding grounds. The records of this species combined with those of many others seem to indicate that the earliest fall migrants travel at a higher speed than the earliest spring migrants. This high speed in the case of the pectoral sandpiper is continued to South America and brings the first to Argentina by the end of August (Sclater and Hudson).

The regular fall migration of the young birds is a full month later, and they reach the coast of Ungava after the middle of August (Coues). Some late dates are: Northern coast of Siberia, August 20 (Pelzeln); Point Barrow, September 6, 1882 (Murdoch); St. Michael, September 6, 1899 (Osgood); Unalaska Island, October 5, 1899 (Bishop); Nushagak, Alaska, October 15, 1884 (Osgood); southern British Columbia, average October 16, latest October 25, 1905 (Brooks); Terry, Mont., October 21, 1905 (Cameron); Great Bear Lake, August 29, 1903 (Preble); Montreal, average October 25, latest November 1, 1890 (Wintle); Ottawa, Ontario, average October 29, latest November 5, 1895 (White); Lincoln, Nebr., November 4, 1899 (Wolcott); Keokuk, Iowa, November 24, 1900 (Currier); Carlisle, Pa., November 2, 1844 (Baird); Raleigh, N. C., November 15, 1894 (Brimley). A gunner near Newport, R. I., who shot 2,337 birds in 1867–1874, killed most of them between August 10 and October 10—extreme dates July 16, 1870, and October 20, 1874 (Sturtevant).

White-rumped Sandpiper. *Pisobia fuscicollis* (Vieill.).

Breeding range.—The only nests and eggs of the white-rumped sandpiper so far reported are those taken near the coast of Franklin Bay, Mackenzie, and on the neighboring Barren Grounds (MacFarlane). The species was seen near Cumberland Sound July, 1878 (Kumlien), under such conditions as to make it probable that it was breeding, and is recorded as breeding at Cape Fullerton, Hudson Bay (Low). Many specimens have been taken on the west coast of Greenland from near the southern end north to Upernivik, latitude 73° (Winge), but there is no proof that any of these were breeding. At Point Barrow, Alaska, the species was noted June 6–July 6, 1883 (Murdoch), and June 2–14, 1898 (Stone), but again there is no certainty of breeding. None of the expeditions that lived and collected on Boothia Peninsula and Melville Peninsula mention this species, and it is not known to breed south of Hudson Strait. It is evident, therefore, that the thousands of individuals of this species are crowded during the breeding season into a rather narrow belt of tundra extending from near the mouth of the Mackenzie east to the southern end of Baffin Land.

Winter range.—Few species of shorebirds have so many records for Patagonia as the white-rumped, and this is also one of the species that is erroneously said to breed in the Southern Hemisphere. It winters abundantly from Paraguay and Argentina to the Falkland Islands (Sclater and Salvin) and the southern coast of Tierra del Fuego (Schalow). It is rare or casual on the coast of Chile (Gay) and unknown on the rest of the western coast of South America, except one seen at Chorillos, Peru (Taczanowski), and one taken October 12, 1864, near Huanaracama, Peru (specimen in United States National Museum).

Migration range.—During migration the white-rumped sandpiper is common along the whole eastern coast of South America, in the West Indies, and in the United States east of the Rocky Mountains. The western edge of the migration route extends from the upper Mackenzie through western Saskatchewan and eastern Colorado to the coast of southern Texas and then turns east to northern Yucatan and the island of Trinidad. The species is only an accidental visitant to Mexico (Salvin), Central America, and the whole of northwestern South America. Accidental once in California (Bryant) and several times in Europe.

Spring migration.—The species arrives in Cuba in April (Gundlach) and has been recorded in northern Yucatan April 15 (Salvin). Nearly all the dates of arrival in the United States are in May, from Florida to Maine and from Massachusetts to Colorado. The first was seen at Indian Head, Saskatchewan, May 9, 1892 (Macoun); Fort Chipewyan, Alberta, May 30, 1893 (Russell); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); Cape Fullerton, Hudson Bay, May 22, 1904 (Eifrig). There are indications that the larger number pass north in spring by way of the Mississippi Valley and return in fall along the Atlantic coast; but some individuals are found on the Atlantic coast in spring, though rare north of Virginia, and a few occur in the eastern Mississippi Valley in fall. The most surprising feature of this bird's migration is its late stay in spring south of its breeding grounds. Near Cape Horn, South America, it was abundant the winter of 1882–83 and remained until March 7, 1883 (Oustalet). It remains in southeastern Argentina until late April (Holland), and a single specimen was taken at Colonia, Uruguay, in June (Sharpe). The species remains regularly in Brazil until May (Pelzeln); one was taken on Inagua, Bahamas, May 27, 1879 (Cory); Amelia Island, Florida, May 30, 1906 (Worthington); Erie, Pa., June 4, 1875 (Sennett); Stafford County, Kans., June 6, 1907 (Peabody); Waukegan, Ill., June 9, 1876 (Nelson); Toronto, Ontario, June 21, 1898 (Nash); and at Indian Head, Saskatchewan, the last did not leave for the north until July 1, 1892 (Macoun).

Fall migration.—By early July the species is already moving south and arrived soon after July 1, 1886, at Prince of Wales Sound, Ungava (Payne), just south of the breeding grounds. During the month of July the van appears all along the New England coast, and even reaches Barbados (Feilden). August finds the species in Brazil (Pelzeln), and the collectors near Cape Horn in 1882 recorded the arrival of the first September 9 (Oustalet).

The main part reaches the northern United States in August, usually about the second week; the last leave the breeding grounds soon after the 1st of September, and the birds are seldom seen on the New England coast after the middle of October. One was taken at Ossining, N. Y., October 21, 1879 (Fisher), and a late migrant was taken at Lake Drummond, Virginia, November 5, 1898 (Fisher).

Baird Sandpiper. *Pisobia bairdi* (Coues).

Breeding range.—The Baird sandpiper has been found breeding at Point Barrow, Alaska (Murdoch), in the vicinity of Franklin Bay, Mackenzie (MacFarlane), and at Cambridge Bay, Franklin (Collinson). These localities probably represent the real extremes of the breeding range, for east or west of these limits the species is known very rarely even in migration.

Winter range.—During migration the Baird sandpiper has been noted near the summit of one of the highest mountains of Colorado at 14,000 feet (Drew). The same tendency to seek a high altitude is shown in the winter home, for this species has been taken repeatedly in the high mountains of northern Chile at 10,000 to 12,000 feet, and one specimen was secured at over 13,000 feet altitude (Sclater). Chile seems to be the principal winter home of the species, and it has been recorded here south to Talcahuano, latitude 36° 30′ S. (Sharpe). It is said to have occurred in Patagonia (Carbajal), but no definite locality is given, and in Argentina it seems not to have been recorded south of Buenos Aires (Sclater and Hudson).

Migration range.—The route the Baird sandpiper traverses between its winter and summer homes is yet to be determined. In spring migration the species is practically unknown east of the Mississippi River, and is abundant on the coast of Texas, on the plains, and in the Rocky Mountain region. Though many individuals occur in the eastern United States in fall, yet the bulk retraces its spring course and leaves the United States to the southward of the plains region. It has been noted in a few places in Mexico in fall: Colonia Garcia, Chihuahua, September 4; Chihuahua City, October 3 (Nelson); San Jose del Cabo, September 3–13 (Brewster); Janos River, Chihuahua, September 5 (Wolfe); Las Vigas, Jalapa, September (Sharpe); and Zacatecas, August 16 (Sharpe); here the record ends. The species is not recorded for Guatemala, Honduras, or Nicaragua. It is a common fall migrant in Ecuador (Salvadori and Festa), but the only records between Mexico and Ecuador are: Volcano Irazu, Costa Rica, June 8 (Cherrie); La Estrelle de Cartago, Costa Rica, November 5, 1907 (Carriker); and Medellin, Colombia (Sclater and Salvin), without date of observation.

Not many years ago the Baird sandpiper was considered merely accidental on the Atlantic coast. The past few years have witnessed a great increase of data. It is now known to be a regular and not rare migrant east to Lake Huron (Wood), Lake Erie (Todd), and the western end of Lake Ontario (Nash), and there are 50 or more printed records for the Atlantic coast region, from Four Mile Run, Va. (Matthews), north to Digby, Nova Scotia (Macoun). What becomes of these Atlantic coast birds is not yet known, for the species seems to be unrecorded in the United States south of the Ohio River and east of Mississippi, and is not known in the West Indies. It ranges regularly west to British Columbia (Brooks), but to the southward the flocks seem to pass inland west of the Sierra and are common in Nevada (Ridgway) and Arizona (Henshaw), but rare in California, where it has been taken at Point Pinos (Mailliard) and September 8, 1904, at Pacific Beach (Bishop).

Spring migration.—The Baird sandpiper is a much earlier migrant than its eastern relative, the white-rumped. It appears on the coast of Texas in early March (Brown); the average date of arrival in central Nebraska is March 24, earliest March 19, 1890 (Powell); Loveland, Colo., March 29, 1890 (Smith); southern British Columbia, April 29, 1889, and 1905 (Brooks); Indian Head, Saskatchewan, May 9, 1892 (Macoun); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); near Dyer, Alaska, May 15, 1882 (Hartlaub); Kowak River, Alaska, May 20, 1899 (Grinnell); Point Barrow, Alaska, average of three years May 29, earliest May 28, 1898 (Stone). The date of arrival at Point Barrow is worthy of notice, for at this time the birds' breeding grounds on the tundra were covered deep with snow, and it had to wait some weeks before it could begin nesting. The earliest eggs at Fort Anderson were found June 24, 1864 (MacFarlane); the next year, young were noted July 5, and downy young were taken at Point Barrow July 16, 1898 (Stone).

The species remains in Chile until the last of March (Lane), and is common in Texas to the middle of May (Lloyd). A late migrant was taken June 1, 1903, at Iguala, Guerrero (Nelson and Goldman). The last usually leave Nebraska before the first of June, but in 1900 one was seen at Lincoln on June 29 (Wolcott). The last was noted at Indian Head, Saskatchewan, June 2, 1892 (Macoun), and at Fort Chipewyan, Alberta, June 1, 1893 (Russell).

Fall migration.—Several flocks already in fall migration were seen at Great Slave Lake, Mackenzie, July 10, 1901 (Preble). Since the earliest young are not hatched until the first week in July, it is evident that these flocks of July 10, already several hundred miles south of the breeding grounds, must consist either of barren birds or of those that had suffered loss of their eggs. In southern British Columbia, the average date of arrival is August 11, earliest August 6, 1888 (Brooks); near Monterey, Calif., August 25, 1897 (Mailliard); southern Saskatchewan, July 17, 1906 (Bishop); southern Manitoba, July 23, 1881 (Macoun); Lincoln, Nebr., August 9, 1900 (Wolcott); southern Ontario, July 28, 1891 (Nash); Locust Grove, N. Y., August 18, 1885 (Henshaw); Boston Harbor, August 27, 1870 (Henshaw); Montauk, N. Y., August 14, 1907 (Braislin). In September it reaches its winter home in southern South America.

The last were seen at Point Barrow, Alaska, August 12, 1883 (Murdoch), and September 4, 1897 (Stone); southern British Columbia, September 15, 1903 (Brooks); Fort Lyon, Colo., September 28, 1885 (Thorne); Lincoln, Nebr., November 3, 1900 (Wolcott); southern Ontario, October 20, 1893 (Elliott); New Haven, Conn., October 28, 1887 (Woodruff); Galapagos Islands, October 6, 1897 (Rothschild and Hartert).

Least Sandpiper. *Pisobia minutilla* (Vieill.).

Breeding range.—The least sandpiper nests in the far north to northern Ungava (Turner); at Cambridge Bay in southern Franklin (Collinson); the coast of Mackenzie (MacFarlane); and Kotzebue Sound, Alaska (Grinnell). Unlike most of the Arctic breeding shorebirds, it breeds also quite far south to Sable Island (Oates); Magdalen Islands (Job); northeastern Quebec (Audubon); upper Hamilton River, Ungava (Low); Fort Churchill, Keewatin (Preble); Lake Marsh, southern Yukon (Bishop); and in Alaska south to Yakutat Bay (Merriam). The western limit of the breeding range in Alaska is not yet definitely settled.

Winter range.—The species is recorded without exact locality from Chile (Salvin), has been taken at several places in Peru (Taczanowski), and ranges south in Brazil to Pernambuco (Allen). Thence it is known throughout northern South America, Central America, Mexico, and the West Indies, the coast of Georgia (Helme), rarely in winter to North Carolina (Bishop), southern Texas (Merrill), southern Arizona (specimen in United States National Museum), and southern California, north at least to Owen Lake (Fisher) and Humboldt Bay (Townsend).

Migration range.—Beyond the known breeding range, the least sandpiper is found in fall on the west coast of Greenland north to Godhaven, latitude 69° (Walker); at Plover Bay, Siberia (Bean). It occurs during most if not all the summer on the Alaska Peninsula (Osgood) and on the Aleutian Islands west to Unalaska (specimen in United States National Museum).

Spring migration.—Though wintering so far north, this species is one of the later shorebirds to migrate. Most of the migrants cross the United States in early May, as shown by the following dates of arrival: Long Island, New York, average May 4, earliest April 21, 1906 (Latham); eastern Massachusetts, average May 8; city of Quebec, average May 2, earliest April 28, 1900 (Dionne); Chicago, Ill., average May 8, earliest May 4, 1898 (Gault); Oberlin, Ohio, average May 12, earliest May 8, 1905 (Jones); southern Ontario, average May 15, earliest May 8, 1889 (McIlwraith); Ottawa, Ontario, average May 18, earliest May 10, 1888 (White); Onaga, Kans., average May 11, earliest May 9, 1904 (Crevecoeur); southern Saskatchewan, average May 17, earliest May 12, 1903 (Harvey); Fort Resolution, May 19, 1860 (Kennicott); Fort Providence, May 15, 1905 (Mills); Fort Simpson, May 17, 1904 (Preble); Loveland, Colo., average April 21, earliest April 19, 1890 (Smith); Cheyenne, Wyo., average April 28, earliest April 23 1888 (Bond); Newport, Oreg., average April 29, earliest April 21, 1901 (Bretherton); southern British Columbia, average April 22, earliest April 20, 1905 (Brooks); Nulato, Alaska, May 11, 1867 (Dall); Kowak River, Alaska, May 15, 1899 (Grinnell).

Eggs were taken near Fort Anderson, Mackenzie, June 21, 1862; June 24, 1863, and June 30, 1864 (MacFarlane); Yakutat Bay, Alaska, June 21, 1899 (Merriam); downy young at Lake Marsh, Yukon, July 2, 1899 (Bishop), and an egg ready to lay at the Kowak River, Alaska, June 1, 1899 (Grinnell).

Fall migration.—The following dates of arrival show how very early some individuals of the species must start southward: Sitka, Alaska, common July 2, 1896 (Grinnell); southern British Columbia, July 2, 1889 (Brooks); North Dalles, Wash., July 4, 1897 (Fisher); near San Diego, Calif., July 13, 1894 (Mearns); Fort Bridger, Wyo., July 13, 1858 (Drexler); Lincoln, Nebr., July 14, 1900 (Wolcott); Detroit, Mich., July 9, 1905 (Swales), July 7, 1906 (Taverner); near Toronto, Ontario, July 4, 1891 (Nash); Lexington, Ky., July 16, 1905 (Dean); Long Island, New York, average July 8, earliest July 6, 1898 (Worthington); Bahamas, July 16, 1903 (Riley), July 18, 1904 (Allen); the Lesser Antilles, the middle of July (Feilden); off the coast of Venezuela, July 23, 1892 (Hartert).

Some dates of the last seen are: Cape Blossom, Alaska, August 10, 1898 (Grinnell); southern British Columbia, average September 11, latest September 18, 1903 (Brooks); Aweme, Manitoba, average September 4, latest September 26, 1899 (Criddle); Long Island, New York, September 17, 1905 (Latham); Erie, Pa., October 3, 1895 (Todd); Back River, Maryland, November 3, 1894 (Kirkwood).

Long-toed Stint. *Pisobia damacensis* (Horsf.).

The long-toed stint is a species of eastern Asia, accidental in North America. It breeds in eastern Siberia, Kamchatka, Bering Island, and south to the Kurile Islands; west probably to the valley of the Lena River. This statement of breeding range is based on the occurrence of the species in summer, since the nest and eggs are still unknown. The species passes south for the winter, through China and Japan, to Australia, the Malay Archipelago, Burma, and India. The only record in North America is of a single specimen taken June 8, 1885, on Otter Island, Alaska (Ridgway).

[**Cooper Sandpiper.** *Pisobia cooperi* (Baird).

The Cooper sandpiper is known only from the single specimen now in the National Museum, taken in May, 1833, on Long Island. The status of the species is still in doubt.]

Dunlin. *Pelidna alpina* (Linn.).

The dunlin, an Old World species, has been noted a few times in North America. A specimen was taken October 20, 1842, at Washington, D. C., and two days later a second was secured (Smith); one was captured September 15, 1892, at Shinnecock Bay, Long Island, New York (Young), and one August 11, 1900, at Chatham, Mass. (Howe and Allen). There are less certain records of its occurrence in the region of Hudson Bay (Blakiston). There seems to be no sure record for Greenland, though the regular breeding range extends west to England, Scotland, and Iceland. The species breeds east to Turkestan and probably to the valley of the Yenisei, and north to the islands of the Arctic coast. It winters from Great Britain and the Caspian Sea south to northern Africa and India.

Red-backed Sandpiper. *Pelidna alpina sakalina* (Vieill.).

Breeding range.—The red-backed sandpiper has two well-defined breeding areas corresponding in general to the Atlantic and Pacific winter ranges. The birds of the Atlantic coast breed from northeastern Ungava (Weiz) and Cape Fullerton, Hudson Bay (Low), north to Bellot Strait (McClintock). A few (of either this form or the last) breed on the west coast of Greenland, from which country there are eggs in the United States National Museum. The birds of the Pacific coast breed in Alaska from the mouth of the Yukon (Nelson) north to Point Barrow (Murdoch), and on much of the northern coast of Siberia west possibly to Yenisei River (Seebohm). The region of intergradation along the coast of Siberia is not yet definitely determined. These two breeding areas are separated by nearly 1,500 miles of Arctic coast, from Point Barrow to the Boothia Peninsula, and throughout this whole region there seems to be no certain record of the occurrence of the red-backed sandpiper. If it does occur, it must be very rare, and the probability that it does not is increased by the fact that the species is not known as a migrant in the region immediately to the south. It is abundant as a migrant along the west coast of Hudson Bay (Preble) and has been taken at Dawson, Yukon (Cantwell), but as yet is unrecorded in the intervening districts.

Winter range.—Few of the shorebirds go so short a distance to the southward as the red-backed sandpiper. It is common in winter as far south as central Florida (Scott), but is unknown in the Bahamas and the West Indies. On the coast of Texas it ranges to the mouth of the Rio Grande (Merrill), but is not yet known in northeastern Mexico. On the Pacific coast it is abundant south to southern Lower California (Belding), but seems not to pass farther south. The only record south of the region just outlined is that of a specimen, undoubtedly a straggler, taken May 23, at Momotomba, Nicaragua (specimen in British Museum). During the winter the species remains north to the coasts of North Carolina (Bishop), New Jersey, casually (Stone), Louisiana (Beyer), Texas (Carroll), and at least to central Washington (Bowles). The Siberian birds of this form winter from Japan and China to the Malay Archipelago.

Spring migration.—Most of the spring movements occur in May, but a few early birds press northward in April: Long Beach, New Jersey, April 17, 1877 (Scott); Long Island, New York, April 3, 1882 (Chapman); Erie, Pa., April 21, 1900 (Todd). On the Atlantic coast north of Massachusetts the species is not so common in spring as in fall, while around the Great Lakes the reverse is the case. The main body of the Atlantic coast birds seem to reach their breeding grounds by way of the Great Lakes and Hudson Bay. Along this route they are late migrants, reaching southern Ontario on the average May 20, earliest May 13, 1905 (Taverner).

The Pacific coast birds appeared in southern British Columbia April 25, 1888 (Brooks), and April 26, 1889 (Brooks); one was seen as early as April 2, 1897, at Howcan (Cantwell), in the extreme southern part of Alaska. Other dates of spring arrival are: Fort Kenai, May 16, 1869 (Osgood); Kigulik Mountains, May 17, 1905 (Anthony); Dawson, Yukon, May 24, 1899 (Cantwell); Point Barrow, Alaska, May 31, 1882 (Murdoch), May 29, 1883 (Murdoch), and June 2, 1898 (Stone).

None were noted in Lower California after May 10 (Belding), but in central Florida they have been recorded as late as June 2, 1886 (Scott), and in southern Ontario the average date of the last seen is June 4, latest June 13, 1891 (Nash).

Eggs have been taken at the mouth of the Yukon, June 6, 1879 (Nelson); Cape Prince of Wales, June 27, 1898 (Grinnell); and at Point Barrow, June 22, 1883 (Murdoch). At this last locality the eggs in some seasons must be laid earlier than the above date, for in 1898 downy young were taken July 6 (Stone).

Fall migration.—Early fall migrants were passing south July 19, 1900, along the west shore of Hudson Bay, near York Factory (Preble), and two weeks later they were enormously abundant, showing that this is one of the principal routes in fall migration. Since the species is not common in the Mississippi Valley and is comparatively rare in western Ontario in the fall, it is evident that many of these Hudson

Bay birds turn eastward to the Atlantic coast. An early arrival appeared on Long Island, New York, July 17, 1897 (Worthington), but the usual time of arrival is a month or more later; Hayward, Calif., August 3, 1889 (Emerson); Point de Monts, Quebec, August 28, 1883 (Merriam); Plymouth, Mass., September 17, 1852 (Browne); Erie, Pa., September 21, 1875 (Sennett); Washington, D. C., September 25, 1894 (Hasbrouck).

The last deserted the breeding grounds at Point Barrow, Alaska, September 7, 1882 (Murdoch); September 4, 1897 (Stone). The last have been noted at St. George Island, Alaska, October 3, 1899 (Bishop); Bering Island, October 25, 1884 (Grebnitsky); Chicago, Ill., November 3, 1906 (Ferry); Oberlin, Ohio, October 27, 1906 (Jones); St. Clair Flats, Michigan, November 20, 1904 (Blain); Ottawa, Ontario, average October 4, latest October 29, 1889 (White); Portland, Me., November 11, 1906 (Eastman); Barnstable, Mass., December 23, 1903 (Howe); Comox, British Columbia, December 5, 1903 (Brooks).

Curlew Sandpiper. *Erolia ferruginea* (Brünn.).

The curlew sandpiper breeds only in the Eastern Hemisphere, but wanders not infrequently to the Atlantic coast of North America. The only eggs so far known were taken July 3, 1897, in the delta of the Yenisei River, Siberia (Newton), and June 24–July 6, 1900, on the northwestern coast of the Taimyr Peninsula, Siberia (Dresser). It is probable that all Greenland records for this species are erroneous, and that the only reliable record in Arctic America is that of the single individual taken June 8, 1883, at Point Barrow, Alaska (Murdoch). On the Atlantic coast of America it has been recorded about twenty times from Halifax, Nova Scotia (Jones), to Cape May, N. J. (Abbott). A few dates are in May, but the larger part are in the fall from August to October. One specimen was taken about 1886 in the interior at Toronto, Ont. (Fleming). The species has been recorded from Grenada Island, West Indies (Cory), and there is a specimen in the British Museum said to have been taken in eastern Patagonia.

In winter the curlew sandpiper ranges south to southern Africa, India, the Malay Archipelago, and Australia. During migration it has been noted in the Philippines and China, and west to Great Britain.

Spoon-bill Sandpiper. *Eurynorhynchus pygmeus* (Linn.).

The spoon-bill sandpiper inhabits the Eastern Hemisphere and ranges in summer to northeastern Siberia. It migrates through Japan and China and winters as far south as Burma and India. One was taken in 1849 on the Choris Peninsula of Alaska—the only record for the Western Hemisphere.

Semipalmated Sandpiper. *Ereunetes pusillus* (Linn.).

Breeding range.—The semipalmated sandpiper breeds in Ungava at Okak (Crandall) and south to Fort George (Drexler), and also on the Barren Grounds from Hudson Bay (Eifrig) west to Franklin Bay (MacFarlane), along the Arctic coast to Kotzebue Sound, Alaska (Grinnell), and south on the western coast of Alaska to St. Michael (specimens in United States National Museum).

Winter range.—It winters mainly in eastern South America, south to Patagonia (latitude 43° S.) (Seebohm), and thence north through Central America and the West Indies to eastern Mexico (Sumichrast), southern Texas (Refugio County; Carroll), Florida (Scott), and the coast of Georgia (Helme) and South Carolina (specimen in United States National Museum).

Migration range.—The semipalmated sandpiper is a rare spring but an abundant fall migrant along the whole Atlantic coast. It is a common fall migrant through the Bermudas (Hurdis), Bahamas (Bryant), and the West Indies east of Cuba. It is common both spring and fall in the Mississippi Valley, becoming less common westward to the eastern base of the Rocky Mountains, and west of the mountains to western British Columbia (Brooks), Sitka, Alaska (Bischoff), Cook Inlet (Chapman), Norton Sound (McGregor), St. Paul Island (Palmer), and the coast of northeastern Siberia (Nelson). It has occurred in migration on the coast of Peru (Salvin).

Spring migration.—Almost all the spring records for the Atlantic coast are in May, while migration in the Mississippi Valley begins in April: Camden, Ind., average of three years April 21, earliest April 18, 1886 (Groninger); Keokuk, Iowa, average of eight years April 30, earliest April 19, 1898 (Currier); Fort Lyon, Colo., April 25, 1886 (Thorne); Indian Head, Saskatchewan, May 16, 1892 (Macoun); Fort Chipewyan, Alberta, May 24, 1901 (Preble); Great Bear Lake, Mackenzie, May 24, 1826 (Richardson); Kowak River, Alaska, May 29, 1899 (Grinnell). Nonbreeding birds are found here and there in summer from Wisconsin (Kumlien and Hollister) to Massachusetts (Howe and Allen).

Eggs have been taken at Fort George, Ungava, June 24, 1860 (Drexler); Franklin Bay, Mackenzie, June 30, 1864 (young July 5, 1865), (MacFarlane); St. Michael, Alaska, June 9, 1880 (specimens in United States National Museum); and young just hatched at Cape Blossom, Alaska, June 30, 1898 (Grinnell).

Fall migration.—Like so many other sandpipers the semipalmated begins to move south so early that it appears in the United States in July; southern Mississippi, average of three years July 16, earliest July 10, 1905 (Brodie and Kopman); Fernandina, Fla., July 14, 1906 (Worthington); Porto Rico, August 11, 1901 (Bowdish); La Guaira, Venezuela, August 10 (Robinson and Richmond), and Marajo, Brazil, August 4 (Allen). Specimens were taken July 3, 1907, at Coronado de Terraba, Costa Rica (Carriker), but these may have been nonbreeders that had not made the northward journey. Young birds migrate about a month later, and it is probably these that afford the following average dates: North River, Prince Edward Island, August 8 (Bain); Long Island, New York, August 10 (Worthington); Beaver Pa., August 14 (Todd); Keokuk, Iowa, August 18 (Currier).

The average date of the last one seen at Point Barrow, Alaska, is August 15, latest August 18, 1882 (Murdoch); Herschel Island, Yukon, August 2, 1894 (Russell); York Factory, Keewatin, August 26, 1900 (Preble); Ottawa, average of the last one seen September 9, latest September 17, 1892 (White); Lewiston, Me., October 17, 1900 (Johnson); Ossining, N. Y., October 20, 1885 (Fisher); Washington, D. C., October 26, 1887 (Richmond).

Western Sandpiper. *Ereunetes mauri* Cabanis.

Breeding range.—The western sandpiper's breeding range, as at present known, is a narrow strip along the northwestern coast of Alaska from the mouth of the Yukon (specimens in United States National Museum) to Cape Prince of Wales (Grinnell).

Winter range.—Though breeding only on the northwest coast, this sandpiper is common in winter on the Atlantic coast from North Carolina (Bishop) to Florida (Scott). This long migration across the continent to the southeastward from the breeding grounds is very remarkable, and is not paralleled in the case of any other shorebird. It is, however, comparable with the migration of several species of ducks from the Mackenzie Valley to Chesapeake Bay. The species also winters from La Paz, Lower California (specimen in National Museum), to southern Mexico (Lawrence), Guatemala (Sharpe), Colombia (Ridgway), and Venezuela (Robinson), and undoubtedly to the Lesser Antilles, but its distribution in the West Indies is not yet known with any accuracy.

Migration range.—In passing from the summer to the winter home, the western sandpiper comes east to the Atlantic coast at least as far north as Massachusetts (Henshaw), and sometimes is quite common in the fall on Long Island (Braislin) and the coast of New Jersey (Baily). The strange fact is that there are no corresponding records from the interior to indicate the route by which these birds reach New England. The species seems not to be known north of southern Wisconsin (Kumlien and Hollister), Colorado (Osburn), and southern Wyoming (specimen in National Museum), while in all of the Mississippi Valley between the river and the Rocky Mountains the species is so very rare as to make it improbable that any large part of the New England birds migrate through this section. In fall migration the species is known west in the Aleutians to Unalaska Island (Palmer).

Spring migration.—Along the Atlantic coast the species is almost unknown in spring north of its winter range; the few known occurrences are in May. To the westward some dates of spring arrival are: Galveston, Tex., March 24, 1891 (Singley); San Pedro River, Arizona, April 17, 1902 (Howard); Monterey, Calif., April 6, 1903 (Brenninger); Redwood City, Calif., April 14, 1907 (Carriger and Pemberton); Corvallis, Oreg., April 21, 1899 (Woodcock); southern British Columbia, April 26, 1889, and April 20, 1905 (Brooks); Fort Kenai, Alaska, May 12, 1869 (Bischoff); St. Michael, May 28, 1874 (Turner).

Most of the individuals have left southern Lower California by May 10 (Belding) and the northern part by the middle of the month (Kaeding). The species was still present at Owen Lake, California, June 1, 1891 (Fisher). Eggs have been found at the mouth of the Yukon June 5 (specimens in United States National Museum) and near Cape Prince of Wales, June 28, 1898 (Grinnell).

Fall migration.—The first fall migrants were noted at Tulare Lake, California, July 7–8, 1907 (Goldman), and the species was taken off the coast of Venezuela July 7, 1895 (Robinson). The first of these records probably represents birds in migration; the other, nonbreeders that had summered far south of the breeding grounds. Some other fall records are: Southern British Columbia, average of five years August 14 as the date of fall arrival (Brooks); Semiahmoo Bay, Washington, July 15, 1857 (Kennerly); Santa Barbara, Calif., July 3, 1875 (Sharpe); Fort Bridger, Wyo., July 13, 1858, (Drexler); near Arco, Idaho, July 25, 1890 (Merriam); Rockport, Tex., August 12, 1905 (Howell); Monomoy Island, Massachusetts, July 19, 1888 (Brewster); Charleston, S. C., about July 8 (Wayne); Haiti, July 11, 1883 (Stone); San Mateo, Tehuantepec, August 7, 1869 (specimen in United States National Museum). The latest date in southern British Columbia is September 11, 1889 (Brooks); Hayward, Calif., November 4, 1889 (Emerson); Monomoy Island, Massachusetts, September 19, 1888 (Brewster); Cape May County, N. J., September 15, 1895 (Baily); Washington, D. C., September 22, 1894 (Hasbrouck).

Sanderling. *Calidris leucophæa* (Pallas).

Breeding range.—The sanderling is a cosmopolite, breeding and wintering in both hemispheres. It is known to breed north to Point Barrow, Alaska (Stone), Melville Island (Fisher), Grinnell Land (Feilden), both coasts of Greenland (Bessels and Winge), the Taimyr Peninsula, Siberia (Walter), and undoubtedly breeds on the New Siberian Islands (Newcombe). It breeds south to Iceland (Oates), to Cape Fullerton, Hudson Bay (Low), and to Franklin Bay, Mackenzie (MacFarlane).

Winter range.—Some sanderlings pass in winter to central Argentina (Tambo Point, 44° S.: Durnford), and to Talcahuano, central Chile (Sharpe), 8,000 miles from the nearest breeding grounds; while others remain as common winter residents on the Atlantic coast of the southeastern United States north to North Carolina (Smithwick) and casually even to Massachusetts (Mackay). The species winters on the coast of Texas (Merrill) and on the Pacific coast regularly to central California (Cooper) and occasionally to Washington (Cooper and Suckley).

It occurs in fall migration on the Hawaiian Islands, where it has been taken from September 25 to October 14 and where a few may winter (Henshaw).

The sanderlings of the eastern hemisphere winter from the Mediterranean and Japan south to southern Africa, the Malay Archipelago, and Oceania.

Migration range.—The sanderling is common on the coasts of the world and on the larger inland waters. It is abundant on both coasts of North America and common on the Great Lakes. It has been recorded in migration from almost every State of the Union, but is quite rare in all the district between the Great Lakes and the Pacific coast.

Spring migration.—The northward movement begins in March, bringing the species the latter part of this month to the New England coast and to the central Mississippi Valley. Further advance is so slow that the sanderling is among the later birds to arrive at the breeding grounds, which are reached the first week in June. Some dates of spring arrival are: Fort Simpson, Mackenzie, May 29, 1904 (Preble); Point Barrow, Alaska, latitude 71°, June 2, 1882 (Murdoch), June 6, 1898 (Stone); Prince of Wales Strait, 73°, June 7, 1851 (Armstrong); Bay of Mercy, 74°, June 3, 1852 (Armstrong); Winter Island, 66°, June 10, 1822 (Lyon); Igloolik, 69°, June 16, 1823 (Parry); Grinnell Land, 82° 33′, June 4, 1876 (Feilden); west coast of Greenland at 72°, May 29, 1850 (Sutherland); at 78°, June 5, 1854 (Kane); Taimyr Peninsula, Siberia, 74°, June 4 (Seebohm). Specimens were taken in Chile in May (Schalow); in British Honduras May 18–20 (Salvin); southern Florida, May 25 (Scott); the coast of New Jersey, June 13 (Abbott). The species remains regularly on the New England coast and about the Great Lakes until the first week in June. The fact that nonbreeders remain through the summer far south of the nesting grounds has probably furnished the basis for the reports of the breeding of the species south of the Arctic coast.

The first eggs known to science were taken June 29, 1863, near Franklin Bay, Mackenzie (MacFarlane), a locality where the species is very rare. The most northern known eggs were taken June 24, 1876, near the north coast of Grinnell Land, at latitude 82° 33′ (Feilden). Eggs were taken in July at Thank God Harbor, Greenland (Bessels), and both late June and early July on the Taimyr Peninsula, Siberia (Walter).

Fall migration.—The sanderling was seen off the coast of Venezuela July 7, 1895 (Robinson), but regular fall migration does not begin until some weeks later, as shown by the following dates of fall arrival, which in each case are considerably earlier than the average: Big Stick Lake, Saskatchewan, July 19, 1906 (Bent); Lincoln, Nebr., August 7, 1900 (Wolcott); Toronto, Ontario, July 16, 1898 (Nash); Newfoundland, August 2, 1887 (Palmer); Erie, Pa., July 27, 1900 (Todd); Long Island, New York, July 20, 1900 (Scott); San Mateo, Tehuantepec, August 5, 1869 (Sumichrast). The last was seen at Point Barrow, August 27, 1897 (Stone); St. Michael, Alaska, September 11, 1899 (Bishop); Homer, Alaska, August 29, 1901 (Chapman); Prince of Wales Strait, August 30, 1850 (Armstrong); Grinnell Land, about August 31, 1882 (Greely); Prince Edward Island, October 30, 1887 (Bain); Montreal, Canada, October 7, 1889 (Wintle); Lincoln, Nebr., October 4, 1898 (Bruner, Wolcott, and Swenk); Ottawa, Ontario, October 22, 1887 (White); Erie, Pa., November 17, 1902 (Todd).

Marbled Godwit. *Limosa fedoa* (Linn.).

Breeding range.—Formerly the marbled godwit was a common breeder in northern Nebraska (Say), in northern Iowa south to about latitude 43° (Preston), and a few undoubtedly nested in Wisconsin, at about the same latitude (Kumlien and Hollister). It is not probable that the species now breeds in either State, and the principal summer home at the present time is from northern North Dakota (Rolfe) to the valley of the Saskatchewan (Bent).

Winter range.—The species passes south in winter to southern Guatemala (Salvin) and Belize (Sclater and Salvin), and remains as far north as southern Lower California (Forrer) and the coasts of Louisiana (Beyer), Florida (Scott), and Georgia (Worthington).

Migration range.—On the way from the summer home to the winter, some individuals formerly took a course almost due east and appeared in the Maritime Provinces of Canada (Macoun) and on the coast of New England (Brown), becoming more common to the south until it would hardly have been called rare on Long Island and the New Jersey coast. At the present time it is almost unknown on the Atlantic coast north of Florida. There seem to be no winter records of the species in the West Indies, but as a rare visitant in fall migration it has been recorded from Cuba (Gundlach), Porto Rico (Gundlach), Grenada (Wells), Carriacou (Wells), and Trinidad islands (Leotaud).

A migration also takes place westward to the Pacific coast. Though the species is not known to breed within several hundred miles of the Rocky Mountains, yet it has been noted on the coast of southern Alaska (Osgood) nearly a thousand miles west of the nearest breeding grounds. This species therefore presents the unique spectacle of a bird breeding in the middle of the American continent and migrating directly east and directly west to the ocean coasts. A wanderer was taken at Point Barrow, Alaska, August 26, 1897 (Stone), and several specimens have been taken on Hudson Bay (Preble). Individuals probably sometimes winter in California, as one was taken at Humboldt Bay, December 7, 1885 (Townsend), and at Lake Elsinore, February, 1902 (Nordhoff).

Spring migration.—The marbled godwit is among the earlier migrants of the shorebirds; it reaches central Illinois in early April (Griffin); Heron Lake, Minnesota, average April 12, earliest April 8, 1889 (Miller); Lincoln, Nebr., April 18, 1899 (Wolcott); Loveland, Colo., average April 27, earliest April 20, 1887 (Smith); Shoalwater Bay, Washington, April 13, 1854 (Cooper); southern Manitoba, average May 1, earliest April 29, 1901 (Wemyss); southern Saskatchewan, average May 3, earliest April 16, 1907 (Lang). Nearly all of the few spring records on the Atlantic coast are in May.

Eggs have been found at Oakland Valley, Iowa, April 20, 1878 (Rice); Winnebago, Iowa, May 6, 1871 (Krider); Miner County, S. Dak., May 16, 1892 (Patton); Minnewaukan, N. Dak., May 22, 1892 (Rolfe); in Grant County, Minn., May 24, 1876 (Sonnett); and in southern Saskatchewan, May 29, 1905 (Bent). The birds and their young were common June 8, 1820, near the mouth of the Loup Fork of the Platte, Nebraska (Say).

Fall migration.—The return movement begins in July, since migrants have been taken at Ugashik, Alaska, July 16, 1881 (Osgood), on the New Jersey coast late in the month (Stone), and on Pea and Bodie islands, North Carolina, July 11, 1904 (Bishop). A gunner who shot for the market near Newport, R. I., obtained only 26 of these godwits during eight seasons, the extreme dates ranging from August 6, 1873, to October 2, 1868 (Sturtevant). The latest date in Colorado is October 1, 1874 (Henshaw).

Pacific Godwit. *Limosa lapponica baueri* Naum.

The principal breeding range of the Pacific godwit is in northeastern Siberia, but a few individuals cross to Alaska and breed from Unalaska (Dall) to Kotzebue Sound (Grinnell). After the breeding season some wander northward to Point Barrow (Murdoch). They arrive on their breeding grounds early in May (Nelson), and are among the earliest of the waders to begin the fall migration (Nelson). The latest one seen at Point Barrow was August 18 (Murdoch), and early in September the last have left North America. The migration route passes through the Pribilof Islands, Commander Islands, Japan, China, and the Philippines. The winter home is in Australia, New Zealand, the Malay Archipelago, and many of the islands of Oceania. The Pacific godwit has been noted several times in the Hawaiian Islands (Bryan), and a straggler was once taken at La Paz, Lower California (Belding).

Hudsonian Godwit. *Limosa hæmastica* (Linn.).

Breeding range.—The eggs of the Hudsonian godwit are known only from the Anderson River region of northwestern Mackenzie (MacFarlane), but since Edward A. Preble, of the Biological Survey, found the species common in July and August on the west coast of Hudson Bay, probably it breeds also not far north of this region. The breeding range is probably the Barren Grounds from the mouth of the Mackenzie to Hudson Bay.

Winter range.—The species winters in Argentina and Chile south to Chiloe Island (Sclater and Salvin) on the west coast and to the Strait of Magellan (Sharpe) and the Falkland Islands (Abbott). But it is rare in eastern Patagonia south of the Chubut River (Durnford), which is just opposite the southern limit on the western coast.

Migration range.—The migration route between the winter and summer homes is not known. In fall migration the species appears rarely on the coast of Maine (Boardman) and more commonly in Massachusetts (Howe and Allen), Rhode Island (Sturtevant), and Long Island (Dutcher). Whither the birds go when they leave Long Island is as yet unknown. On the rest of the coast of the United States the species is known only as a very rare straggler. One accidental occurrence in Cuba (Gundlach) is the only record for the Greater Antilles, and in the Lesser Antilles it is known only from the extreme eastern end on Barbados (Feilden) and Trinidad (Leotaud). It occurs on the coast of British Guiana (Quelch) and in the interior of Brazil (Pelzeln).

The species seems not to be recorded in spring anywhere on the Atlantic coast between Argentina and Long Island, with the exception of a single pair seen May 8, 1906, near Rehoboth, Del. (Pennock). The very few records on Long Island (Sharpe) and in New England (Howe and Allen) during the spring indicate that at this season it is only a straggler along the Atlantic. It passes in spring migration up the Mississippi Valley, entering the United States through Louisiana (Beyer) and Texas (Sharpe) and passing north principally along the eastern edge of the plains. The migration route between Argentina and Texas is unknown, for there is not a single spring record in the whole distance, and records at any time in the year are limited to one on the coast of Peru, November 9, 1883 (MacFarlane); one in Cuba, no date specified (Gundlach); and very doubtful records for Colombia (Burger) and Costa Rica (Zeledon).

From the above very meager data, it seems probable that the Hudsonian godwit has a migration route similar to that of the golden plover, with this important difference—that whereas the golden plover first goes eastward from its breeding grounds to the coast of Labrador and crossing the Gulf of St. Lawrence strikes out to sea from Nova Scotia, the Hudsonian godwit starts in a south-easterly course to and down the western shore of Hudson Bay and keeps much this same course overland to the coast of New England. Thence it goes directly across the ocean to the Lesser Antilles and British Guiana, and lastly south and southwest through central Brazil to the pampas of Argentina, and to the coast of central Chile. Judging by analogy from the golden plover, the spring migration route of the Hudsonian godwit is from the pampas of northwestern Argentina directly to the coast of Texas, and almost in one flight.

This species is rare west of the Rocky Mountains. The British Museum contains specimens said to have been taken in California (Sharpe), but as this is the only record for the State it needs confirmation. A few specimens have been taken in Alaska from the Kenai Peninsula (Osgood) to the Yukon mouth (Dall and Bannister), Nulato (Sharpe), and Point Barrow (Stone) on the north, but there is no evidence that the species breeds west of the Mackenzie River. Though the Hudsonian godwit is now very rare on the New England coast, and has been since about 1886, yet previously it was so common that a gunner near Newport, R. I., records the shooting of 104 birds in the years 1867–1874 (Sturtevant).

Spring migration.—The species arrives on the coast of Texas in April (Sharpe) and has been recorded at Lawrence, Kans., as early as April 19, 1873 (Snow); St. Louis, Mo., April 19, 1872 (Hurter); in Grant County, Minn., April 25, 1876 (Sennett); Indian Head, Saskatchewan, May 11, 1892 (Macoun); Fort Kenai, Alaska, May 5, 1869 (Bischoff). Specimens were taken on the Falkland Islands as late as May 20, 1860 (Abbott), and in Argentina to May 24 (Sharpe). The earliest eggs taken were on June 7, 1862, at Fort Anderson (MacFarlane).

Fall migration.—A Biological Survey party found the Hudsonian godwit already in southward migration July 19, 1900, near York Factory, Keewatin (Preble); it was noted July 29, 1869, on the coast of Rhode Island (Sturtevant); it arrives in August in the Lesser Antilles (Leotaud); in September in Brazil (Pelzeln); and by early November has appeared at the extreme southern limit of the range (Durnford). It is probably the arrival of young birds that is recorded at Barbados (Feilden) in October, with October 7 as the average of three years and October 5, 1886, as the earliest.

The last seen near Cape Churchill, Hudson Bay, in 1900, was on August 24 (Preble); Toronto, Ontario, October 20, 1890 (Fleming); Montreal, Canada, October 11, 1895 (Wintle); Rhode Island, October 13, 1873 (Sturtevant), and Massachusetts, November 3 (Howe and Allen).

Black-tailed Godwit. *Limosa limosa* (Linn.).

The black-tailed godwit is confined to the Eastern Hemisphere, breeding in Iceland, and from Holland and southern Russia north to the Arctic Circle and east to western Siberia. It winters in southern

Europe and south to Abyssinia. A specimen was taken about 1830 near Godthaab, Greenland (Reinhard), and there are other less certain records of its occurrence in that country.

Green-shank. *Glottis nebularia* (Gunn.).

The green-shank has a very wide range in the Eastern Hemisphere. It breeds in Scotland, northern Scandinavia, and east to northern Siberia; it migrates along the coasts of both Europe and Asia, even to Japan and the Commander Islands; it winters from southern Europe and India to southern Africa and Australia.

The only record for the United States is that of three specimens taken by Audubon, May 28, 1832, on Sand Key, near Cape Sable, Florida. The species has also been recorded as an accidental visitant to Chile (Schlegel) and Buenos Aires, Argentina (Seebohm).

Common Red-shank. *Totanus totanus* (Linn.).

The common red-shank is scarcely entitled to a place among North American birds. Its claim rests only on the description by Swainson and Richardson of a specimen from Hudson Bay which they said existed in the British Museum.

The common red-shank is a well-known species of Europe and Asia, where it breeds from Iceland and the Faroe Islands to southern Siberia and Turkestan and south to northern Africa. It winters in southern Europe, throughout most of Africa, and in Asia south to India and the Malay Archipelago.

Greater Yellow-legs. *Totanus melanoleucus* (Gmel.).

Breeding range.—Knowledge of the summer home of the greater yellow-legs is much lacking in definiteness. One of the best known facts is that the bird does not go far north, since it is one of the few species of the family not found on the Arctic coast, nor even to the Arctic Circle. The most northern records are: Near Fort Chimo, Ungava (Turner); accidental once at Cumberland Sound (Kumlien); on the west shore of Hudson Bay to about Cape Eskimo (Preble); Fort Simpson, Mackenzie (Ross); and to Kupreanof Island (Osgood), Lake Iliamna (Osgood), and St. Paul Island (Seale)—all in Alaska. The southern limit of the breeding range is more difficult to determine, since the mere presence of the bird in summer is not sufficient proof that it is breeding. Individuals are found during every month of the year in the West Indies, Bahamas, Florida, Texas (Sennett), and California (Grinnell), but it is not probable that the species breeds in any of these localities.

Eggs taken in British Columbia at Fort George and Fort St. James (specimens in United States National Museum) are probably the only certainly identified eggs of the species known. The bird probably breeds in British Columbia as far south as Clinton (Rhoads), and eastward across Canada, north of about the fiftieth parallel of latitude.

Winter range.—The greater yellow-legs winters to the southern end of the mainland of South America. To the north it occurs on both coasts and in Central America, Mexico, and the West Indies to the coast of

Georgia (Helme)—occasionally to North Carolina (Bishop)—Louisiana (Edwards), Texas (Merrill), and California. In this latter State it winters on the coast north at least to Los Angeles County (Grinnell), and in the interior to Owen Lake (Fisher).

Spring migration.—The advance begins in March, and the first reach Raleigh, N. C., on the average April 3, earliest March 22, 1893 (Brimley); Long Island, New York, average April 22, earliest April 17, 1896 (Worthington); eastern Massachusetts, average April 26, earliest April 22, 1893 (Browne); southern Maine, average May 9, earliest April 26, 1896 (Morrell); city of Quebec, Canada, average April 30, earliest April 18, 1903 (Dionne); Point de Monts, Quebec, average May 5, earliest April 26, 1885 (Comeau). Lake Mistassini, Quebec, May 7, 1885 (Macoun). Some other early dates along the Atlantic coast are: Patapsco Marsh, Maryland, March 26, 1875 (Kirkwood); Carlisle, Pa., March 19, 1844 (Baird); Westport Harbor, Massachusetts, March 10, 1899 (Howe and Sturtevant). The average date of arrival in central Illinois is April 6, earliest March 22, 1890 (Brown); Chicago, Ill., average April 24, earliest April 14, 1895 (Blackwelder); Oberlin, Ohio, average April 18, earliest April 12, 1905 (Jones); southern Michigan, average April 27, earliest April 24, 1897 (Hankinson); southern Ontario, average April 28, earliest April 13, 1896 (Taverner); Ottawa, Ontario, average May 9, earliest April 28, 1905 (White); Keokuk, Iowa, average April 14, earliest March 26, 1893 (Currier); Elk River, Minn., average April 21, earliest April 17, 1886 (Bailey); Aweme, Manitoba, average May 4, earliest April 30, 1902 (Criddle); Kansas City, Mo., March 9, 1903 (Bryant); Manhattan, Kans., March 11, 1883 (Lantz); Lincoln, Nebr., April 10, 1899 (Wolcott); Fort Lyon, Colo., March 28, 1886 (Thorne); Loveland, Colo., March 26, 1890 (Smith); Cheyenne, Wyo., April 11, 1888 (Bond); Great Falls, Mont., April 17, 1892 (Williams); Rathdrum, Idaho, April 20, 1901 (Danby); Fort Simpson, Mackenzie, May 23, 1860 (Ross), May 16, 1904 (Preble); Chilliwack, British Columbia, March 28, 1888 and 1889 (Brooks); Fort Kenai, Alaska, May 6, 1869 (Bischoff).

Those individuals that are to breed leave the United States by the first week in June. The species is common in Chile and Argentina through the winter and to early April, when most leave for the north, but some remain the whole summer in Argentina (Holland), 6,000 miles south of the breeding range.

Eggs have been taken at Fort St. James, British Columbia, May 31, 1889 (MacFarlane), and at Fort George, British Columbia, May 20, 1890 (specimens in United States National Museum). The earliest downy young noted in 1901 in the Caribou district, British Columbia, were seen on June 15 (Brooks).

Fall migration.—Hardly six weeks elapse between the passage of the last northward-bound migrants on Long Island, New York, and the appearance of the first fall migrants; on the average the last in spring pass May 28, latest June 14, 1901 (Scott), while the average date of fall arrival is July 19, earliest July 10, 1887 (Scott). The larger flights there do not come until August, and the species is most common in September and October. Formerly this was one of the common species of shorebirds and one much sought by gunners. A hunter near Newport, R. I., shot 1,362 greater yellow-legs in the eight seasons 1867–1874, on dates ranging from July 20, 1870, to November 4, 1870; his highest score, 419 birds, was in 1873, from August 19 to October 19. Dates of fall arrival are: Granville, Wash., July 7, 1897 (Young); Utah Lake, Utah, July 26, 1872 (Henshaw); Aweme, Manitoba, average July 29, earliest July 27, 1901 (Criddle); Lipscomb, Tex., one June 29, common July 8, 1903 (Howell); Pacheco, Chihuahua, July 30, 1905 (Brown); Toronto, Ontario, July 28, 1891 (Nash); Cullingham Cove, Ungava, July 31, 1891 (Norton); Anticosti Island, July 8, 1881 (Brewster); Erie, Pa., July 28, 1896 (Todd); Washington, D. C., July 24, 1890 (Richmond); Bahama Islands, July 6, 1904 (Allen); Barbados, West Indies, July 25, 1886 (Manning); Bonaire Island, off the coast of Venezuela, July 21, 1892 (Hartert).

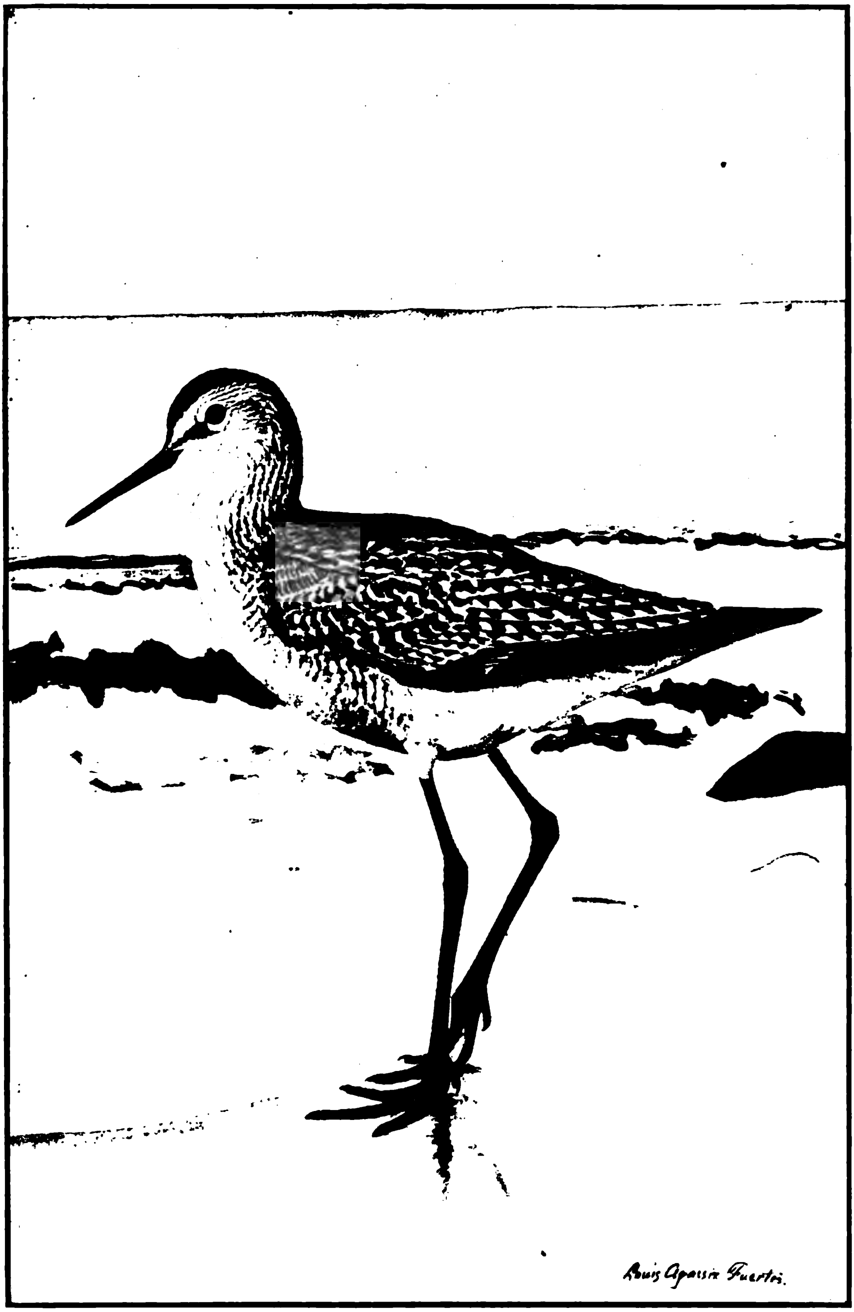
Dates of the last seen are: Near Fort Churchill, Keewatin, August 8, 1900 (Preble); Hayes Run, Keewatin, August 30, 1900 (Preble); Oxford House, Keewatin, September 10, 1900 (Preble); Cumberland Sound, September 14, 1877 (Kumlien); near Fort Chimo, Ungava, September 19, 1882 (Turner); Portage la Prairie, Manitoba, October 21, 1884 (Nash); Chilliwack, British Columbia, November 17, 1888, (Brooks), November 21, 1889 (Brooks); Long Island, New York, average November 5, latest November 20, 1901 (Scott). The late dates of departure explain the name winter yellow-legs for this species.

Yellow-legs. *Totanus flavipes* (Gmel.).

Breeding range.—The principal summer home of the yellow-legs is the Barren Grounds and neighboring regions to the southward. The species ranges north to southern Ungava (Selwyn), central Keewatin (Preble), and nearly to the Arctic coast in northern Mackenzie (MacFarlane). It breeds north to Kotzebue Sound (Townsend) and Fort Yukon (Dall and Bannister), but apparently does not occur on the northern coast of Alaska. The southern limit of the breeding range is imperfectly known; the species breeds in Yukon at least south to Lake Marsh (Bishop), and in the interior probably to southern Alberta (Macoun), southern Saskatchewan (Macoun), and northern Quebec (Macoun).

Winter range.—The yellow-legs passes south in winter to the Strait of Magellan (Gay) and occurs at this season quite generally over the southern half of South America, and even in the mountains up to 10,000 feet (Sclater). Winter records north of this region are few, and probably only a comparatively small number regularly winter

PLATE I.


Louis Agassiz Fuertes.

YELLOW-LEGS (TOTANUS FLAVIPES).

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north of South America. A few winter in southern Mexico, as far north as Cozumel Island (Sharpe) and La Barca, Jalisco (Goldman); a few are noted occasionally in Louisiana (Beyer) and in Florida in winter (Pillsbury), and the species occurs rarely in the Bahamas at this season (Bonhote).

Migration range.—The yellow-legs is common on the Atlantic coast in fall and many pass through the Lesser Antilles. In this latter region it is practically unknown in spring, and it is rare in spring migration on the Atlantic coast north of Long Island, New York. These facts would seem to indicate that some yellow-legs pursue different migration routes in fall and spring. The species is a common migrant in the Mississippi Valley both spring and fall, and hence probably most of those that go south through the Lesser Antilles return in spring to their breeding grounds by way of the Mississippi Valley.

The species is not common on the Atlantic coast north of the Gulf of St. Lawrence, though one was taken October 8, 1882, near Fort Chimo, Ungava (Turner), and two have been taken in southern Greenland (Winge).

The yellow-legs is rarely seen west of the Rocky Mountains, but a few occur along the coast from northern Alaska (Grinnell) to southern Lower California (Brewster). One was taken June 11, 1890, on St. Paul Island (Palmer).

Spring migration.—The following dates show the usual time at which the yellow-legs arrives in its northward migration: Northern Texas, average March 26, earliest March 22, 1899 (Mayer); central Missouri, average April 14, earliest April 9, 1903 (Bryant); Keokuk, Iowa, average April 16, earliest March 11, 1894 (Currier); central Nebraska, average April 28, earliest March 27, 1900 (Wolcott); Chicago, Ill., average April 23, earliest April 15, 1899 (Gault); Oberlin, Ohio, average April 28, earliest April 23, 1904 (Jones); Raleigh, N. C., average April 1, earliest March 25, 1893 (Brimley). The following are dates of occurrence somewhat earlier than the average: Cumberland, Ga., March 12, 1902 (Helme); Washington, D. C., March 12, 1906 (Green); Havre de Grace, Md., March 15, 1895 (Kirkwood); near Newport, R. I., April 28, 1902 (King); Godbout, Quebec, May 5, 1888 (Comeau); San Antonio, Tex., March 20, 1903 (Norton); Bay St. Louis, Miss., March 13, 1902 (Allison); Sioux City, Iowa, March 11, 1864 (Feilner); southern Ohio, March 18, 1901 (Henninger); Lanesboro, Minn., April 7, 1890 (Hvoslef); Fort Lyon, Colo., March 30, 1886 (Thorne); Indian Head, Saskatchewan, April 25, 1892 (Macoun); Edmonton, Alberta, May 1, 1901 (Preble); Fort Reliance, Yukon, May 3 (Nelson); Fort Resolution, Mackenzie, May 5, 1860 (Kennicott); Willow River, Mackenzie, May 9, 1904 (Mills and Jones); Fort Reliance, Mackenzie, May 13, 1834 (Back); Fort

Franklin, Mackenzie, May 16, 1826 (Richardson); Fort Anderson, Mackenzie, May 27, 1865 (MacFarlane). The yellow-legs is thus about the earliest shorebird to reach high northern latitudes.

Eggs were taken at Fort Resolution June 1, 1860 (Kennicott); near Fort Anderson, June 15, 1863, June 20, 1864, and June 16, 1865 (MacFarlane); and downy young July 1, 1899, at Lake Marsh, Yukon (Bishop).

Fall migration.—Like so many other waders, the yellow-legs begins its southward journey early in July, so early indeed that migrants have appeared on the Bermudas by July 13 (Reid). Other dates of fall arrival are: Chilliwack, British Columbia, July 25, 1889 (Brooks); Fort Lyon, Colo., July 23, 1884 (Thorne); Aweme, Manitoba, July 26, 1901 (Criddle); Toronto, Ontario, July 18, 1891 (Nash); near Chicago, Ill., July 3, 1893 (Dunn), abundant by July 25 (Parker); Long Island, New York, July 14, 1887 (Scott), July 9, 1905 (Latham); Long Beach, New Jersey, July 9, 1877 (Scott); James Island, Florida, July 20, 1901 (Williams); Key West, Fla., July 16, 1888 (Scott); Inagua, Bahamas, July 28, 1891 (Cory); Jamaica, August 2, 1891 (Field); the average date of arrival in the Lesser Antilles is about July 25, earliest July 4, 1888 (Feilden); Santo Domingo, Venezuela, July 24, 1903 (Briceno); Fortin Page, Argentina, September 13, 1890 (Kerr). The yellow-legs is one of the earliest birds to migrate in fall, and the greater number have left the breeding grounds by the latter part of August. A few linger quite late, as shown by the following dates of the last seen: Near Fort Chimo, Ungava, October 8, 1882 (Turner); Montreal, Canada, October 7, 1898 (Wintle); Scotch Lake, New Brunswick, October 28, 1901 (Moore); Ottawa, Ontario, October 18, 1901 (White); Lanesboro, Minn., October 11, 1888 (Hvoslef); Oberlin, Ohio, October 18, 1899 (Jones); Long Island, New York, October 18, 1905 (Latham); Erie, Pa., October 14, 1893 (Todd); Lincoln, Nebr., November 17, 1900 (Wolcott).

Solitary Sandpiper. *Helodromas solitarius* (Wils.).

Breeding range.—Few facts are known concerning the breeding range of this species. It has been seen in summer over a great extent of country; the young only a few days old have been noted in widely separated localities, but the nest and eggs are almost unknown. The species as a whole, including the eastern and western forms, ranges north in summer to Newfoundland (Reeks); Fort Chimo, northern Ungava (Turner); Great Bear Lake, Mackenzie (Richardson); and to Kowak River, in northwestern Alaska (Grinnell). The southern limit of the breeding range is entirely undetermined. The birds stay in summer as far south as Pennsylvania (Todd), Illinois (Ridgway), Nebraska (Cary), Colorado (Cooke), and Washington (Dawson).

Winter range.—There seem to be no winter records whatever of the western form of the solitary sandpiper. There is every reason for believing that it winters in South America, and has not been distinguished there from the eastern form. The following statement of the winter range doubtless includes both forms, but it is not safe to conclude that the eastern form goes to eastern South America and the western form to the Pacific coast. It is known that the eastern form migrates to the Pacific coast of Mexico, and it is probable that thence southward the two forms commingle both in migration and during the winter. The species as a whole ranges south in winter to Buenos Aires, Argentina (Barrows); to Caiza, in southeastern Bolivia (Salvadori); and to Chorillos, central Peru (Taczanowski). It occurs regularly also at this season in northern South America to Guiana (Quelch), Venezuela (Berlepsch and Hartert), and Colombia (Salvin and Godman). North of South America it is not common anywhere in winter, and it may not winter at any of the following places, but it has been noted as late as December in Porto Rico (Bowdish), Costa Rica (Todd), Yucatan (Sharpe), Veracruz (Sharpe), and northern Lower California (Stephens).

Migration range.—A specimen was taken in Greenland August 1, 1878, at Kangek, latitude 64° (Hagerup); and one of the eastern form was taken October 28, at San José del Cabo, Lower California (Brewster).

Spring migration.—The following records include both the eastern and western forms: The species arrives in the southern United States in March; Tallahassee, Fla., March 25, 1901 (Williams); Coosada, Ala., March 28, 1878 (Brown); Bay St. Louis, Miss., March 17, 1902 (Allison); New Orleans, La., average March 16, earliest March 5, 1900 (Allison); Boerne, Tex., March 25, 1880 (Brown); while some of the earliest records in California are at Los Angeles, April 21, 1897 (Grinnell), and Gridley, April 23, 1891 (Belding). Further progress northward is decidedly slow, as shown by the following dates of arrival: Raleigh, N. C., average April 24, earliest April 4, 1889 (Brimley); near Asheville, N. C., average April 22, earliest April 9, 1890 (Cairns); Washington, D. C., average April 28, earliest April 25, 1900 (Preble); Englewood, N. J., average April 30, earliest April 28, 1900 (Lemmon); near New York City, average May 4, earliest April 30, 1899 (Thayer); Renovo, Pa., average May 4, earliest May 1, 1897 (Pierce); eastern Massachusetts, average May 6, earliest May 2, 1891 (Long); southwestern Maine, average May 11, earliest April 28, 1903 (Swain); Petitcodiac, New Brunswick, May 14, 1887 (Willis); Pictou, Nova Scotia, May 7, 1894 (Hickman); Lake Mistassini, Quebec, May 23, 1885 (Macoun); central Iowa, average April 25, earliest April 10, 1899 (Savage); Chicago, Ill., average April 23, earliest April 7, 1887 (Coale); Bloomington, Ind., average May 2, earliest April 23, 1903 (McAtee); Oberlin, Ohio, average April 29, earliest April 18, 1909 (Jones); Ottawa, Ontario, average May 11, earliest May 2, 1896 (White); southern Wisconsin, average May 6, earliest April 25, 1897 (Russel); Lanesboro, Minn., average May 6, earliest April 24, 1888 (Hvoslef); near San Antonio, Tex., average April 17, earliest March 25, 1880 (Brown); central Kansas, average May 2, earliest April 23, 1885 (Kellogg); Harrisburg, N. Dak., average May 5, earliest May 3, 1904 (Eastgate); Aweme, Manitoba, average May 13, earliest May 9, 1906 (Criddle); Colorado Springs, Colo., May 1, 1882 (Allen and Brewster); Terry, Mont., May 7, 1903, May 9, 1904 (Cameron); Athabaska Landing, Alberta, May 5, 1901 (Preble); Sandy Creek, Alberta, May 14, 1903 (Preble); Fort Providence, Mackenzie, May 14, 1905 (Jones); Fort Simpson, Mackenzie, May 10, 1904 (Preble); Great Bear Lake, May 14, 1826 (Richardson); Fort Steilacoom, Wash., May 6, 1856 (Suckley); Chilliwack, British Columbia, May 7, 1888 (Brooks); Nulato, Alaska, May 15, 1867, May 18, 1868 (Dall); Kowak River, Alaska, May 18, 1899 (Grinnell).

One of the parties of the Biological Survey took downy young June 23, 1903, at Charlie Creek, Alaska (Osgood); eggs are reported from central Alberta, June 24, 1908, June 15, 1908, June 1 and June 9, 1909 (Thayer and Arnold), and young in the nest were found June 19, 1908, at Stony Plain, Alberta (Stansell).

Fall migration.—Early dates in the fall south of the breeding range are: Washington, D. C., average July 21, earliest July 15, 1899 (Howell); Raleigh, N. C., average July 25, earliest July 14, 1894 (Brimley); Key West, Fla., July 28, 1888 (Scott); New Orleans, La., July 20, 1899 (Kopman); Kerrville, Tex., July 20, 1903 (Lacey); Camp Apache, Ariz., July 29, 1873 (Henshaw); Bermudas, July 19, 1874 (Reid); St. Croix, West Indies, July 26, 1857 (Newton); San José del Cabo, Lower California, August 25, 1887 (Brewster); near Buenos Aires, Argentina, August 20, 1880 (Barrows).

Dates of the last seen are: Chilliwack, British Columbia, September 13, 1889 (Brooks); Aweme, Manitoba, September 18, 1904 (Criddle); Chicago, Ill., October 6, 1899 (Gault); Lincoln, Nebr., October 20, 1900 (Wolcott); Ottawa, Ontario, October 31, 1906 (White); Hillsboro, Iowa, October 20, 1899 (Savage); Delavan, Wis., October 20, 1892 (Hollister); Lexington, Ky., October 23, 1904 (Dean); Pictou, Nova Scotia, October 8, 1894 (Hickman); Scotch Lake, New Brunswick, October 5, 1901 (Moore); southwestern Maine, October 21, 1904 (Norton); Renovo, Pa., October 14, 1897 (Pierce); Chesapeake Beach, Md., November 2, 1906 (Riley); Beaver, Pa., November 28, 1901 (Todd).

Western Solitary Sandpiper. *Helodromas solitarius cinnamomeus* (Brewst.).

The western solitary sandpiper occurs in western North America and ranges at least as far east as Great Slave Lake (Preble), Athabaska Lake (Preble), the eastern foothills of the Rocky Mountains in Colorado (Henshaw), and to central Texas (Gaut). It migrates throughout western Mexico and east to Veracruz (Sartorius) and Tehuantepec (Sumichrast). As already stated, the winter range has not yet been determined.

Green Sandpiper. *Helodromas ocrophus* (Linn.).

The green sandpiper, an Old World species, is widely distributed breeding from the Pyrenees to southern Siberia, principally in the mountains. It winters from southern Europe and Japan, throughout Africa, and to Ceylon. It is supposed to have occurred at Halifax, Nova Scotia (Harting), and in the Hudson Bay Company's territory (Nuttall), but the evidence is not conclusive.

Wood Sandpiper. *Rhyacophilus glareola* (Linn.).

The wood sandpiper is one of the best known of the Old World sandpipers. It breeds over most of Europe and Asia from the valley of the Danube and northern China to the Arctic coast. It winters from the Mediterranean and India to southern Africa and the Malay Archipelago. The only record of the species in North America is that of a single specimen taken May 27, 1894, on Sanak Island, Alaska (Littlejohn).

Willet. *Catoptrophorus semipalmatus* (Gmel.).

Breeding range.—The breeding range of the willet on the Atlantic coast has become much restricted of late years. Formerly it bred north, commonly to New Jersey (Giraud), and rarely to Sable Island (eggs in United States National Museum), Yarmouth (Bryant), and Halifax (Brewer), Nova Scotia. It still breeds rather commonly on the islands off the coast of Virginia (Dutcher), and a few may breed in extreme southern New Jersey, but probably at present no willets breed between there and Nova Scotia, where in 1903 it was reported abundant at Barrington (Trotter). It breeds along the south Atlantic coast to Florida (Scott), and throughout the Bahamas (Bonhote.)

Winter range.—On the Pacific coast it migrates in winter to Santa Lucia, southern Peru (Taczanowski), and on the Atlantic coast to the Amazon River (Pelzeln). It occurs also in winter in northern South America (Quelch), the Lesser and the Greater Antilles, the Bahamas (Bonhote), Florida (Worthington), and casually in South Carolina (Hoxie).

Spring migration.—The willet starts north in March. Some dates of spring arrival are: Hog Island, Virginia, average April 12, earliest April 7, 1888 (Doughty); southern New Jersey, average April 19, earliest April 6, 1877 (Scott); Erie, Pa., April 24, 1902 (Todd). The species has been recorded in migration to Newfoundland (Reeks), but it is not known to breed on that island.

Eggs have been taken in the Bahamas from May 15 (Cory) to July 6 (Allen); Sapelo Island, Georgia, April 22, 1888 (specimens in

United States National Museum); Beaufort, N. C., May 8 (specimens in United States National Museum); Cobbs Island, Virginia, May 25, 1875 (Baily); Warner House, N. J., May 19, 1884 (Bellows); Madison, Conn., June 5, 1873 (Merriam); and on Sable Island in June (specimens in United States National Museum).

Fall migration.—A gunner who shot for the market near Newport, R. I., obtained 106 willets during eight seasons, 1867–1874, on dates ranging from July 11, 1871, to September 19, 1869 (Sturtevant). One bird was seen July 2, 1902, at Sakonnet, R. I. (King). The average date of arrival of late years on Long Island, New York, has been August 13, earliest August 4, 1901 (Scott). The last was seen at Plymouth, Mass., October 4, 1852 (Browne); Long Island, New York, September 24, 1905 (Latham); southern New Jersey, average September 9, latest October 17, 1885 (Crane); Hog Island, Virginia, November 1, 1886, and October 27, 1887 (Doughty).

Western Willet. *Catoptrophorus semipalmatus inornatus* (Brewst.).

Breeding range.—The western willet breeds on the coasts of Texas (Merrill) and Louisiana (Beyer) and from northern Iowa (Berry), southern South Dakota (Cheney), and northern California (Beckwith; Christie), north to the southern portions of Manitoba (Thompson), Saskatchewan (Ferry), Alberta (Macoun), and to central Oregon (Bendire).

Winter range.—The western willet winters on the coasts of Louisiana (Beyer) and Texas (Sennett) and on the coast of California north to Humboldt Bay (Townsend). In winter it ranges south into Mexico (Nelson) and probably to southern Guatemala (Salvin). It also passes eastward and winters on the Gulf coast of Florida (Scott).

Spring migration.—Dates of spring arrival are: Stotesbury, Mo., April 8, 1894 (Surber); Keokuk, Iowa, April 30, 1892 (Currier); Lanesboro, Minn., April 26, 1879 (Hvoslef); central Kansas, average April 30, earliest April 28, 1883 (Lantz); northern Nebraska, earliest May 5, 1893 (Bates); northern North Dakota, average May 3, earliest May 1, 1901 (Eastgate); Indian Head, Saskatchewan, May 6, 1892 (Macoun); northern Colorado, average May 1, earliest April 27, 1887 (Smith); Cheyenne, Wyo., average May 4, earliest April 30, 1888 (Bond); Salt Lake City, Utah, April 28, 1897 (Young); Lewiston, Mont., May 2, 1903 (Silloway); Red Deer, Alberta, May 12, 1892 (Farley); Halleck, Nev., May 5, 1871 (specimen in United States National Museum); Fort Klamath, Oreg., April 22, 1887 (Merrill).

Eggs have been taken at Corpus Christi, Tex., May 17, 1882 (Goss); near Turtle Mountain, Manitoba, May 23, 1883 (Thompson); Oneida County, Idaho, May 21, 1879 (Anderson); near Beckwith, Calif., May 28, 1891 (Christie); Camp Harney, Oreg., May 8, 1878 (Bendire); southern Saskatchewan, June 14, 1906 (Bent). Thus the nesting season is about the same throughout the whole breeding range.

Fall migration.—In fall the western willet wanders eastward far beyond the breeding range, even to the Atlantic coast, as shown by the following records: Chicago, Ill., September 2, 1906 (Armstong and Lawson); Miller, Ind., August 14, 1897 (Woodruff); Oberlin, Ohio, September 17, 1906 (Jones); Toronto, Ontario, July 20, 1898 (Fleming); Stony Creek, Conn., August 15, 1897 (Bishop); Keokuk, Iowa, October 27, 1896 (Currier). A wanderer far north of the breeding range was taken at Victoria, British Columbia, August 18, 1898 (Fannin).

Wandering Tattler. *Heteractitis incanus* (Gmel.).

The first information of the breeding range of the wandering tattler was obtained in 1904 by one of the parties of the Biological Survey. A downy young was shot September 5 on Macmillan River in east central Yukon (Osgood). July 28, 1906, a pair were seen by Charles Sheldon near Mount McKinley, south central Alaska, under conditions that left no doubt that they were breeding in the immediate vicinity. It is not probable that the species breeds anywhere south of Alaska, and yet it occurs in the Hawaiian Islands every month of the year (Henshaw); on the coast of California every month from March to October (Bryant), and has been taken July 2, 1900, on the island of Guam, and July 17, 1904, on the Philippine Islands (specimens in the United States National Museum). The species ranges north to Nulato, Alaska (Dall), where it is said by the natives to breed, and occurs about as far north on the Asiatic side of Bering Sea to Plover Bay (Bean), where it was taken in fall migration.

The wandering tattler winters in lower California, the Galapagos (Sharpe), the Hawaiian Islands (Henshaw), and throughout Oceania to the New Hebrides. In migration it occurs on the Commander Islands, along the whole western coast of North America from Mexico to Alaska, and has occurred inland, accidentally at Crater Lake, Oreg. (Bendire), and on the eastern shore of James Bay (Bell).

Spring migration begins in March, bringing the birds to the coast of California (Grinnell) by the latter part of the month. The Aleutian Islands are reached the middle of May (Nelson), and the most northern part of the range by the latter part of the month (Dall).

On the coast of central California, nearly 2,000 miles south of the breeding grounds, the first fall migrants appear with great regularity within a few days of the middle of July, and are common a few days later (Loomis). At about the same time the birds return from the interior of Alaska to the coast, and are common around Bering Sea for the next two months (Nelson). The last leave the northern part of the range about the middle of September (Nelson) and desert the Aleutians a month later (Bishop).

Ruff. *Machetes pugnax* (Linn.).

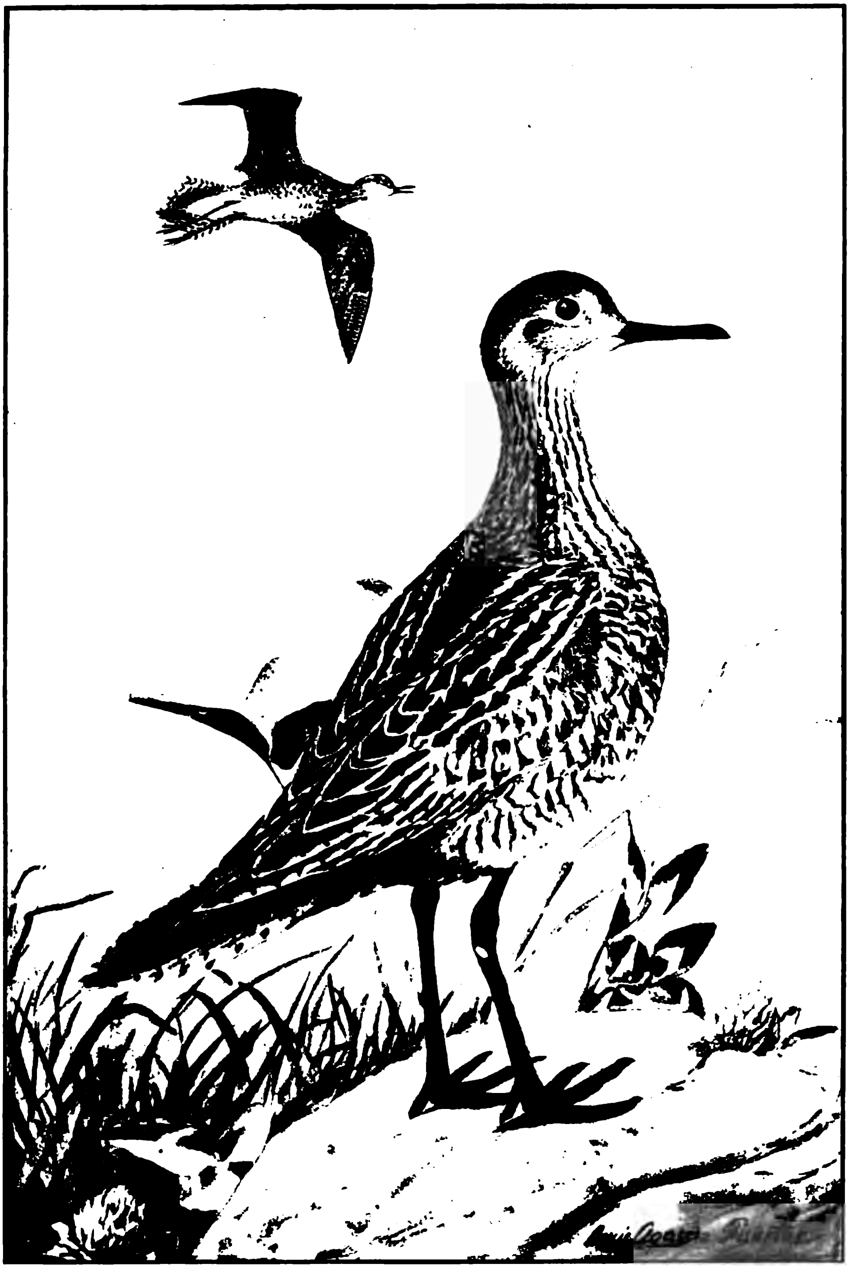
Though an Old World species, the ruff has been taken many times in the Western Hemisphere at widely separated localities as follows: One at Nanortalik, on the southwest coast of Greenland, (Fenckers); Toronto, Ontario, spring of 1882 (Seton); English Lake, Ind., April 12, 1905 (Deane); a specimen in the Ohio State University collection bears the label, "Northern Canada, April 28, 1877" (Dawson); Licking Reservoir, Ohio, November 10, 1872 (Wheaton); Columbus, Ohio, April 28, 1878 (Jones); Grand Manan, New Brunswick, no date (Boardman); Cole Harbor, near Halifax, Nova Scotia, May 27, 1892 (Brewster); Upton, Me., September 8, 1874 (Brewster); Scarborough, Me., April 10, 1870 (Smith); Camden, Me., September 14, 1900 (Thayer); Seabrook, N. H., September 24, 1907 (Hardy); Newburyport, Mass., May 20, 1871 (Brewster); Chatham, Mass., September 12, 1880 (Grinnell); Nantucket, Mass., July, 1901 (Palmer); near Sakonnet Point, Rhode Island, July 30, 1900 (Hathaway); Point Judith, Rhode Island, August 31, 1903 (King); Long Island, New York, one in fall, 1845 (Lawrence), one in October, 1851 (Lawrence), one in May 18, 1868 (Chapman); another specimen seems to have been taken on Long Island, but the date is not recorded (DeKay); Barnegat, N. J., no date (Chapman); Four Mile Run, Va., September 3, 1894 (Palmer); Raleigh, N. C., May 6, 1892 (Brimley); Barbados Island, one before 1848 (Schomburgk), and one in 1878 (Feilden); one in "Spanish America," which probably means near the headwaters of the Rio Negro in northern South America (Pelzeln).

It is thus seen that the ruff has been taken in this hemisphere at least 27 times. Seven of the specimens have no date recorded; 9 were secured in the spring between April 10 and May 27; the other 11 were taken in the fall from July 30 to November 10. As would be expected, most of the specimens are from near the Atlantic coast; only 5 occurred in the interior, the westernmost being the one at English Lake, Indiana.

The breeding range of the ruff is from Great Britain to central Siberia and north to the Arctic coast. The bird winters in Burma, India, and to the southern part of Africa. It has wandered east in Asia to Japan and the Commander Islands, but has not yet been detected on the western coast of America.

Upland Plover. *Bartramia longicauda* (Bechst.).

Breeding range.—The upland or field plover, sometimes called the Bartramian sandpiper, is one of the few shorebirds that nest commonly in the Mississippi Valley. Early in the settlement of this region, much more than half the upland plovers probably nested within the boundaries of the United States. The center of abundance during the breeding season was the prairie region from Kansas to Manitoba.



UPLAND PLOVER (BARTRAMIA LONGICAUDA).

The numbers were not greatly diminished so long as this region was used for stock purposes, but recently the birds have rapidly decreased. At the present time the species breeds south to southern Oregon (Merrill); northern Utah (Ridgway); northern Colorado (Rockwell), central Oklahoma (Merrill), southern Missouri (Prior), southern Indiana (Butler), northern Virginia (Grinnan) and central Maryland (Miller). The summer range extends north to southern Maine (Norton), southern Ontario (Renfrew; Clarke), and southern Michigan (Wood). Then it bends far to the northward through central Wisconsin (Kumlien and Hollister) to central Keewatin (Cape Eskimo; Preble), southern Mackenzie (Fort Smith; Preble), northern Yukon (M'Dougall), and to the Kowak River in northwestern Alaska (Townsend). Stragglers are not uncommon in the Maritime Provinces and have occurred in Newfoundland (Reeks) and to Godbout, Quebec (Merriam). The species is not common east of Michigan nor west of the Rocky Mountains.

Winter range.—The principal winter home is in Argentina (Sclater and Hudson) and probably no upland plovers occur at this season north of the pampas of South America.

Migration range.—In fall this species passes through the Greater and the Lesser Antilles (Feilden), but in the Bahamas (Cory), Jamaica (March), and Porto Rico (Gundlach), it is so much rarer than farther east as to indicate that some individuals reach the Lesser Antilles by direct flight across the ocean. It migrates also through the Gulf States and west to Sulphur Spring, Ariz. (Henshaw), western Mexico (Durango; Nelson), and locally in Central America and the northern parts of South America.

There seem to be no spring records of migration in the West Indies east of Cuba, indicating that the individuals that go south through the Lesser Antilles return by way of Central America. Nor in spring migration is the species recorded west of central Mexico or west of the Rocky Mountains south of Utah. The only record for California is the single bird taken by Vernon Bailey of the Biological Survey at Tule Lake, August 8, 1896.

Spring migration.—The upland plover arrives in Louisiana on the average earlier than in either Florida or Texas. This would seem to prove that it reaches Louisiana by direct flight across the gulf. The average date of arrival in southern Louisiana is March 14, while the date of arrival at the same latitude in Texas is March 28, and in Florida is early April. The earliest dates are: Bonham, Tex., March 5, 1887 (Peters); New Orleans, La., March 9, 1895 (Beyer); and Tallahassee, Fla., March 25, 1901 (Williams). Other dates of arrival on the Atlantic slope are: Raleigh, N. C., average April 7, earliest March 28, 1896 (Brimley); Washington, D. C., March 21, 1896 (Richmond); Holland Patent, N. Y., average April 20, earliest

April 14, 1896 (Williams); central Connecticut, average April 29, earliest April 16, 1896 (Jennings); southern New Hampshire, average April 30, earliest April 22, 1900 (Dearborn); Plymouth, Me., average May 3, earliest April 25, 1878 (Thorne); central Vermont, average May 5, earliest April 30, 1887 (Goodwin); Godbout, Quebec, May 7, 1885 (Merriam).

Migration in the Mississippi Valley begins earlier than on the Atlantic coast and is earlier for corresponding latitudes all the way north to the Canadian boundary, as shown by the following dates of arrival: Odin, Ill., average April 4, earliest March 30, 1895 (Vandercock); Tampico, Ill., average April 11, earliest April 9, 1890 (Brown); Chicago, Ill., average April 16, earliest April 10, 1896 (Gault); Oberlin, Ohio, average April 14, earliest March 22, 1904 (Jones); southern Michigan, average April 20, earliest April 8, 1895 (Alexander); central Iowa, average April 15, earliest April 3, 1893 (Ross); southern Wisconsin, average April 18, earliest April 10, 1853 (Stiles); Heron Lake, Minnesota, average April 24, earliest April 20, 1890 (Miller); Manhattan, Kans., average April 14, earliest April 4, 1882 (Lantz); Onaga, Kans., average April 14, earliest April 7, 1893 (Crevecoeur); southern Nebraska, average April 17, earliest April 6, 1890 (Wilson); northern Nebraska, average April 18, earliest April 7, 1903 (Colt); central South Dakota, average April 23, earliest April 19, 1886 (Cheney); Argusville, N. Dak., average May 5, earliest April 26, 1894 (Edwards); Larimore, N. Dak., average May 5, earliest April 26, 1888 (Eastgate); Aweme, Manitoba, average May 3, earliest April 26, 1899 (Criddle); Lake Como, Wyoming, May 5, 1879 (Williston); Rathdrum, Idaho, average May 12, earliest April 27, 1901 (Danby); Columbia Falls, Mont., average May 12, earliest April 27, 1894 (Williams); Edmonton, Alberta, May 12, 1903 (Preble); Red Deer, Alberta, May 13, 1892, May 11, 1893 (Farley); 150-mile House, British Columbia, May 16, 1901 (Brooks).

In the winter home in Argentina the northern movement begins in February, and most birds are gone by the end of March; a few stragglers remain to April (Sclater and Hudson). The species passes through Peru in March and April (Sclater and Salvin); the last was seen at Piedra Blanca, Bolivia, April 23 (Allen); at Tonantins, Brazil, May 7, 1884 (Berlepsch); Cabanas, Cuba, May 22, 1900 (Palmer and Riley); Teopisca, Chiapas, May 7, 1904 (Goldman); and New Orleans, La., May 19, 1894 (Allison).

Eggs have been secured at Lawrenceville, N. J., May 18, 1889 (Phillips); Holland Patent, N. Y., May 21, 1886 (Williams); Marthas Vineyard, Mass., May 25, 1900 (Durfee); Cornwall, Vt., May 26, 1889 (Parkhill); Philo, Ill., May 4, 1900 (Hess); Winnebago, Ill., May 10, 1864 (Tolman); near Dubuque, Iowa, May 14, 1865 (Blackburn); Beatrice, Nebr., May 16, 1895 (Pearse); near Bryant, S. Dak., May 26, 1895 (Lee); Lewistown, Mont., May 25, 1904 (Silloway); Carberry, Manitoba, May 30, 1886 (Seton); southwestern Saskatchewan, May 29, 1905 (Bent).

Fall migration.—Birds were observed at Lipscomb, Tex., July 10, 1903 (Howell), and as they do not breed in that locality, these were southbound migrants. Observers easily detect the call notes of the upland plover as it passes overhead in the darkness, and these calls are usually the first signs of the fall migration. The earliest notes in 1895 at Baltimore, Md., were heard July 3, 1895 (Kirkwood); at Washington, D. C., the first calls have been heard usually between July 10 and July 16, while in 1896 the birds were seen July 7 (Richmond). The average date of arrival in southern Louisiana is July 23, earliest July 9, 1895 (Blakemore); Gainesville, Tex., July 13, 1885 (Ragsdale); Fort Lyon, Colo., July 12, 1886 (Thorne); Sulphur Springs, Ariz., August 18, 1874 (Henshaw); Chapala, Jalisco, August 27 (Richardson); San Jose, Costa Rica, September 5, 1890 (Cherrie); Barbados, West Indies, August 12, 1886 (Manning); Cienega, Colombia, September 15, 1898 (Allen). In September they first appear on their passage through Peru (Sclater and Salvin), and are noted as arriving at their winter home in Argentina (Sclater and Hudson). The last one was seen September 6, 1903, at Big Sandy, Mont. (Coubeaux); at Fort Lyon, Colo., September 2, 1886 (Thorne); near Cape Eskimo, Keewatin, August 13, 1900 (Preble); Aweme, Manitoba, average September 6, latest September 28, 1897 (Criddle); Onaga, Kans., average September 14, latest October 15, 1896 (Crevecoeur); southern Iowa, average September 20, latest September 30, 1896 (Savage); Livonia, Mich., September 18, 1891 (Alexander); Detroit, Mich., October 20, 1902 (Swales); Chicago, Ill., average September 6, latest September 22, 1906 (Armstrong and Lawson); Lexington, Ky., October 11, 1903 (Dean); New Orleans, La., October 7, 1896 (Kopman); North River, Prince Edward Island, August 25, 1887 (Bain); Pittsfield, Me., September 22, 1895 (Morrell); Taunton, Mass., September 19, 1889 (Scudder); Germantown, Pa., October 2, 1887 (Stone); Key West, Fla., October 3, 1888 (Scott); near Atlanta, Ga., November 27, 1903 (Smith); Escondido, Nicaragua, November 26, 1892 (Richmond); San Jose, Costa Rica, November 15, 1889 (Cherrie); Davila, Panama, November 30, 1900 (Bangs).

Buff-breasted Sandpiper. *Tryngites subruficollis* (Vieill.).

Summer range.—The buff-breasted sandpiper is known to breed from Point Barrow, Alaska (Murdoch), to near Franklin Bay, Mackenzie (MacFarlane). It was taken in June at Repulse Bay (Rae), and undoubtedly breeds along the whole Arctic coast east to Hudson Bay. Not quite so certain is the breeding of the bird on the coast of northeastern Siberia. It was found to be quite common there near Koliuchin Bay, August 1, 1881 (Nelson), and had probably bred there, but no nests or young were found, and the individuals seen may have been early fall wanderers from Alaskan breeding grounds.

Winter range.—It winters in Argentina and Uruguay, south at least to Buenos Aires (Durnford) and Montevideo (Gould).

Migration range.—Many thousand miles separate the summer and winter homes of the species, and the migration route between these widely separated regions seems to be somewhat different from that of any other species. The main body of migrants follows the Barren Grounds to the shores of Hudson Bay, thence almost due south across the Mississippi Valley to the coast of Texas and through Central America to northwestern South America and diagonally across the interior of South America to Argentina.

The buff-breasted sandpiper is a rare fall migrant on the Atlantic coast: Henley Harbor, Labrador, August 20, 1860 (Coues); Port Burwell, Ungava, September 28, 1884 (Bell); Quebec, three records, August 28 (Merriam) to September (Trowbridge); Cape Elizabeth, Me., September 13, 1887 (Knight); Scarboro, Me., September 5, 1907 (Norton); several records on the coast of New England and on Long Island, the latest of which is September 11, 1904, on Long Island (Braislin). South of Long Island there are no recent records, and most of the older ones are open to suspicion. The species was seen once in April in Cuba (Gundlach), twice in the fall on Barbados (Feilden), and a record for the island of Trinidad (Leotaud) is somewhat doubtful. It is practically unknown in spring on the Atlantic coast of the United States. It is not known in the Rocky Mountain region, but on the Pacific coast it has been taken at Cape Flattery, Wash. (Newberry); in southern British Columbia (Brooks); Sitka (Bischoff), St. Michael (Nelson), and Nulato (Dall and Bannister), Alaska.

Spring migration.—Migrants appear in the interior of Brazil (Pelzeln) and in Peru (Sclater and Salvin) during March, but there are no spring migration data for the whole distance between Peru and Texas. In the State of Texas the species was noted April 22, 1887, in Refugio County (Sennett), and April 23, 1877, at Gainesville (Ragsdale). The first were seen at Fort Chipewyan, May 24, 1901 (Preble); Fort Simpson, May 29, 1860 (Ross); Yukon delta, May 30, 1879 (Nelson); St. Michael, May 31, 1880 (Nelson); Point Barrow, June 8, 1882 (Murdoch), and June 6, 1883 (Murdoch).

Eggs were taken on the Barren Grounds near Franklin Bay, June 26, 1864, and June 28, 1865 (MacFarlane); and at Point Barrow, June 18, 1883 (Murdoch).

Fall migration.—The fall migration of this species and of most other waders begins in July, and so rapidly do the birds move south that they have been noted the last of this month in Nebraska (Bruner, Wolcott, and Swenk); Gainesville, Tex., August 4, 1883 (Ragsdale); San Jose, Costa Rica, September 7, 1890 (Cherrie); and Cienega, Colombia, September 12, 1898 (Allen). The southern part of the

SPOTTED SANDPIPER (ACTITIS MACULARIA).

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winter range in Argentina is reached early in October (Sclater and Hudson). A very early migrant was taken August 3, at Pebas, Peru (Sharpe). Usually the species is rare east of the Mississippi River, but several flocks were seen August 16–18, 1874, at Maywood, Ill., near Chicago (Fisher).

Spotted Sandpiper. *Actitis macularia* (Linn.).

Breeding range.—Few shorebirds have so extended a breeding range as the spotted sandpiper. It nests north to Newfoundland (Reeks), the northernmost part of Ungava (Turner), northern Mackenzie (Fort Anderson; MacFarlane), northern Alaska at Fort Yukon (Lockhart), and to the Kowak Valley in northwestern Alaska (Townsend). It breeds south to northern South Carolina (Chester County; Loomis), central Alabama (Greensboro; Avery), southern Louisiana (New Orleans; Beyer), central Texas (Lacey), southern New Mexico (Carlisle; Barrell), central Arizona (San Francisco Mountains; Mearns), and the southern Sierra of California (Walker Pass; Kaeding), and probably on the Colorado River near Needles (Hollister).

Winter range.—The spotted sandpiper ranges south in winter to central Peru (La Merced; Berlepsch and Stolzmann), central Bolivia (San Francisco; Salvadori), and to southern Brazil (Sao Paulo; Ihering). It is not rare in northern South America, and is tolerably common in Central America and Mexico; a few winter in the West Indies, and a small number in the eastern United States to the coast of Georgia (Helme) and to Port Royal, S. C. (Eaton), and in the western United States to southern Arizona (Dwight) and southern California (Grinnell).

Spring migration.—The spotted sandpiper passes north about the middle of the migration season, as shown by the following dates of arrival: Northern Florida, average March 19 (Pleas); Raleigh, N. C., average April 10, earliest April 3, 1893 (Brimley); near Asheville, N. C., average April 13, earliest April 10, 1891 (Cairns); Washington, D. C., average April 22, earliest April 2, 1905 (McAtee); near Waynesburg, Pa., average April 13, earliest April 6, 1893 (Jacobs); Beaver, Pa., average April 20, earliest April 2, 1888 (Todd); Renovo, Pa., average April 18, earliest April 9, 1904 (Pierce); Erie, Pa., earliest April 18, 1900 (Todd); near New York City, average April 26, earliest April 15, 1891 (Burhaus); central Connecticut, average April 25, earliest April 20, 1901 (Case); near Providence, R. I., average May 2, earliest April 21, 1905 (Mason); eastern Massachusetts, average April 28, earliest April 15, 1893 (Metcalf); Randolph, Vt., average May 5, earliest April 28, 1891 (Paine); southern New Hampshire, average May 4, earliest April 28, 1905 (Perkins); southwestern Maine, average May 1, earliest April 14, 1904 (Norton); Montreal, Canada, average May 13, earliest April 26, 1890 (Wintle); central New Brunswick, average May 11, earliest May 5, 1906 (McIntosh); Pictou, Nova Scotia, average May 7, earliest May 3, 1895 (Hickman); North River, Prince Edward Island, average May 14, earliest May 11, 1890 (Bain). The earliest date of arrival at New Orleans, La., is March 19, 1904 (Kopman); Athens, Tenn., average April 14, earliest April 10, 1906 (Gettys); Russellville, Ky., April 9, 1906 (Embody); Brookville, Ind., average April 20, earliest April 14, 1883 (Butler); Waterloo, Ind., average April 27, earliest April 5, 1895 (Hine); Chicago, Ill., average April 30, earliest April 19, 1896 (Gault); Oberlin, Ohio, average April 16, earliest April 9, 1904 (Jones); Petersburg, Mich., average April 22, earliest April 15, 1887 (Trombly); southern Ontario, average April 23, earliest April 13, 1896 (Taverner); Ottawa, Ontario, average April 30, earliest April 24, 1897 (White); southern Wisconsin, average April 27, earliest April 23, 1897 (Russell); Lanesboro, Minn., average April 28, earliest April 18, 1886 (Hvoslef); Onaga, Kans., average May 5, earliest April 26, 1896 (Crevecoeur); Aweme, Manitoba, average May 8, earliest May 2, 1905 (Criddle); Columbia Falls, Mont., average May 7, earliest May 4, 1896 (Williams); Chilliwack, British Columbia, May 9, 1889 (Brooks); Athabaska Landing, Alberta, May 6, 1901 (Preble); Fort Chipewyan, Alberta, May 23, 1893 (Russell); near Fort Providence, Mackenzie, May 17, 1904 (Mills); Fort Simpson, Mackenzie, May 19, 1904 (Preble); Dawson, Yukon, May 24, 1899 (Cantwell); Kowak Valley, Alaska, May 22, 1899 (Grinnell). The species has been seen south of its breeding grounds as late as May in Brazil (Pelzeln), and to the latter part of June on the northern coast of Venezuela (Robinson). The species regularly remains in Cuba (Gundlach) and the Bahamas to early May (Bonhote) and in Mexico to the latter part of the month (Sharpe). The average date of the last seen in northern Florida is May 12, and the latest May 18, 1904 (Pleas).

The date of the laying of the eggs varies but little over the whole extent of the breeding range, as shown by the following dates when the earliest eggs were found: Near Richmond, Va., May 22, 1881 (Robinson); Erie, Pa., May 24, 1893 (Todd); Lawrenceville, N. J., May 27, 1889 (Phillips); Trenton Falls, N. Y., May 19, 1892 (Williams); Canaan, Conn., May 16, 1887 (Tobey); Fall River, Mass., May 14, 1887 (Durfee); Orono, Me., May 24, 1894 (Knight); Montreal, Canada, June 8, 1890 (Wintle); Dunnville, Ontario, May 17, 1884 (McCallum); Big Charity Island, Michigan, May 20, 1903 (Arnold); Cheyenne, Wyo., May 30, 1889 (Bond); Fort Lapwai, Idaho, May 29, 1871 (Bendire); Fort Resolution, Mackenzie, May 23, 1860 (Kennicott); Fort Anderson, Mackenzie, June 9, 1862 (MacFarlane); Fort Yukon, Alaska, June 15, 1862.

Fall migration.—The individual taken on Barbados, West Indies, July 4, 1888 (Feilden), may have been a nonbreeding summer resident, or an early fall migrant, but by the end of July migrants have appeared in the Lesser Antilles, on the coast of Venezuela (Hartert), and in Mexico (Brown); indeed, in 1892 a specimen was taken in northern Lower California the first day of July (Mearns).

The last seen at Chilliwack, British Columbia, was October 9, 1888 (Brooks); average of the last seen at Columbia Falls, Mont., September 19, latest September 22, 1895 (Williams); Aweme, Manitoba, average September 5, latest September 11, 1903 (Criddle); Lincoln, Nebr., September 29, 1900 (Wolcott); Lawrence, Kans., October 14, 1905 (Wetmore); Lanesboro, Minn., November 2, 1886 (Hvoslef); Ottawa, Ontario, average September 18, latest October 28, 1902 (White); southern Ontario, average September 30, latest October 25, 1902 (Saunders); Oberlin, Ohio, average September 20, latest October 30, 1905 (Jones); Scotch Lake, New Brunswick, October 5, 1901 (Moore); southwestern Maine, average October 1, latest October 6, 1900 (Johnson); eastern Massachusetts, average October 7, latest October 14, 1895 (Farmer); Hartford, Conn., average October 8, latest October 12, 1902 (Case); Ossining, N. Y., October 23 (Fisher); Washington, D. C., October 28, 1906 (Fisher); near New Orleans, La., latest November 5, 1902, November 10, 1903 (Allison).

Long-billed Curlew. *Numenius americanus* Bechstein.

Breeding range.—The principal summer home of the long-billed curlew is in the interior of the United States on the northern half of the plains. Southward it has been known to breed to Oklahoma (Camp Supply; Wilcox), northwestern Texas (McCauley), central New Mexico (Los Pinos; Woodhouse), southern Arizona (Sulphur Spring; Henshaw), and northwestern California in the Pit River region (Grinnell). To the northward it breeds to central British Columbia (150-mile House; Brooks), southern Alberta (Bow River; Macoun), southern Saskatchewan (Medicine Hat; Macoun), and southern Manitoba (Seton). The long-billed curlew was formerly common in the eastern part of the Mississippi Valley and abundant on the Atlantic coast, but of late years the numbers have been so reduced that now it is merely casual or accidental east of the Mississippi. There are records of the former breeding of the species in northern Iowa (Preston), Wisconsin (Hoy), southern Michigan (Jackson; Davis), and northern Illinois (Ridgway). The species was an abundant migrant on the southern Atlantic coast and less common north to Newfoundland (Reeks), and there are various surmises that it bred at various places, such as the west coast of Florida (Scott), coast of New Jersey (Wilson), and Prince Edward Island (Boardman), but most if not all of these breeding records were based on the presence of the birds in July, and there seems to be no authentic record of eggs anywhere east of Michigan.

Winter range.—The species winters on the Atlantic coast from South Carolina (Nuttall) to Florida (Allen); on the coast of Louisiana (Beyer) and Texas (Merrill); in southern Arizona (specimen in United

States National Museum); and in California north to Owen Lake (Fisher) and San Francisco (Newberry). It also ranges south through Mexico to the Pacific coast of Guatemala at Chiapam (Salvin). It is a casual wanderer in the West Indies; Cuba, June, July, October (Gundlach); Jamaica, July, 1863 (March); St. Vincent, once in the fall (Lawrence).

Spring migration.—When the long-billed curlew was common on the Atlantic coast, it was seldom seen in spring north of the Carolinas; the few individuals that passed up the New England coast usually appeared in May: Hail Point, Maryland, May 23, 1893 (Kirkwood); Scarboro, Me., May 2, 1866 (Knight). Migration in the Mississippi Valley begins in March:.Eagle Pass, March 5, 1885 (Negley); Pecos City, March 9, 1906 (Ligon); Gainesville, March 4, 1876 (Ragsdale)—all in Texas; Warrensburg, Mo., April 1, 1874 (Scott); Appleton City, Mo., April 3, 1906 (Prier); central Illinois, average April 9; Jasper, Ind., April 2, 1896 (Butler); central Iowa, average April 11, earliest April 3, 1883 (Lindley); northern Nebraska, average April 3, earliest March 28, 1889 (Bates); Vermilion, S. Dak., April 5 ,1884 (Agersborg); central North Dakota, average April 15, earliest April 8, 1886 (Edwards); Aweme, Manitoba, average April 22, earliest April 9, 1902 (Criddle); Apache, N. Mex., March 25, 1886 (Anthony); Utah Lake, Utah, March 30, 1899 (Johnson); northern Colorado, average April 14, earliest April 10, 1889 (Smith); Cheyenne, Wyo., average April 18, earliest April 15, 1889 (Bond); Terry, Mont., average April 16, earliest April 7, 1906 (Cameron); Big Sandy, Mont., average April 19, earliest April 13, 1903 (Coubeaux); Fort Klamath, Oreg., March 28, 1887 (Merrill); Chelan, Wash., April 6, 1896 (Dawson); Okanagan Landing, British Columbia, April 12, 1906 (Brooks).

Eggs have been taken at Camp Harney, Oregon, April 30, 1876 (Bendire); Fort Klamath, Oreg., May 7, 1878 (Mearns); Lewistown, Mont., May 13, 1902 (Silloway); Fort Lapwai, Idaho, May 21, 1871 (Bendire); Cody, Nebr., young just hatched June 23, 1895 (Trostler); southern Saskatchewan, downy young June 1, 1905 (Bent); June 11 and 18, 1906 (Bent).

Fall migration.—Flocks of fall migrants used to appear on the Atlantic coast about the middle of July (Mearns) and reach South Carolina by early August (Hoxie). They returned to Monterey Bay, California, July 17, 1894 (Loomis), and arrived at Cape St. Lucas, Lower California, September 15, 1859 (Xantus). The last one seen at Montreal in 1893 was observed September 21 (Wintle), and on the coast of Massachusetts the species has been noted to October 18 (Howe and Allen).

Hudsonian Curlew. *Numenius hudsonicus* Lath.

Breeding range.—The Hudsonian curlew, or jack curlew as it is called by sportsmen, is known to breed on the barren grounds of northern Mackenzie (MacFarlane) and on the western coast of

Alaska from the mouth of the Yukon (Nelson) north to Kotzebue Sound (Grinnell).

Winter range.—The principal winter home is on the Pacific coast, where the species ranges from Ecuador (Salvadori and Festa) to southern Chile (Chiloe Island; Pelzeln), and is especially abundant toward the southern limit of the range. At this season it occurs also on the coasts of Honduras (Taylor) and Guatemala (Salvin) and north to the southern portion of Lower California (Belding). On the Atlantic coast it occurs during the winter from British Guiana (Quelch) to the mouth of the Amazon (Sharpe).

Migration range.—The species probably does not breed in Greenland, but it has been taken several times on the western coast as far north as Jacobshaven, latitude 69° N. (Winge). It migrates east to Ungava (Turner) and Newfoundland (Reeks), and passes down the Atlantic coast and through the Lesser Antilles to its winter home; but it is almost unknown in the Greater Antilles and in Central America and northwestern South America from Nicaragua to Venezuela. It is a common migrant and a probable breeder along the western shore of Hudson Bay (Preble), but since it is unknown in Saskatchewan and Manitoba it is evident that these Hudson Bay birds turn southeastward and probably reach the New England coast; for the bird is more common on the Massachusetts coast than would be expected from the few individuals that occur in Labrador. The species is scarcely recorded in the whole Rocky Mountain district between central Nebraska and eastern California, and it is a rare migrant in the Mississippi Valley, though a few use this route in both migrations. The main migration route is along the Pacific coast, and it occurs here west to St. Paul Island, Alaska (Palmer).

Spring migration.—Records of arrival in the eastern United States are: Sarasota Bay, Florida, March 22, 1872 (Moore); Port Royal, S. C., April 14 (Mackay); Cobbs Island, Virginia, May 19, 1891 (Kirkwood); Cape May, N. J., April 12, 1907, "ten days ahead of the usual time" (Hand); Shelter Island, N. Y., May 9, 1887 (Worthington); Nantucket, Mass., April 10, 1891 (Mackay); but usually not in Massachusetts before the middle of May. By what route these birds reach the eastern United States coast is as yet unknown, for there are no corresponding records in either the Lesser or the Greater Antilles.

The main migratory flocks reach the coast of southern California the middle of March (Grinnell) and proceeding slowly northward have been noted at Fort Kenai, Alaska, May 18, 1869 (Bischoff); Nulato, Alaska, May 12, 1866 (Pease); Kowak Valley, Alaska, May 17, 1899 (Grinnell); Fort Anderson, Mackenzie, May 29, 1865 (MacFarlane).

Eggs were taken on the barren grounds west of the lower Anderson River in late June and early July (MacFarlane), and in the Kowak Valley June 14–20, 1899 (Grinnell).

Fall migration.—On the western shore of Hudson Bay near York Factory in 1900 the species was seen July 19, and was tolerably common in that region nearly to the first of September (Preble); the earliest date at Toronto, Ontario, is July 4, 1904 (Fleming). The average date of arrival at Nantucket, Mass., is July 20, earliest July 13 (Mackay); earliest at Long Beach, N. J., July 9, 1879 (Stone); Pea and Bodie Island, North Carolina, July 22, 1904 (Bishop); Bermudas, August 14 (Reid); Barbuda, West Indies, August 12, 1877 (Ober). Two specimens were taken July 3, 1907, at Coronado de Terraba, Costa Rica (Carriker), but these may have been nonbreeders that had not made a northern journey.

The individuals breeding in Alaska pass south along the Pacific coast, and have been noted at the Farallons, California, July 16, 1896 (Loomis); Los Coronados Islands, Lower California, August 7, 1902 (Grinnell and Daggett); Chimbote, Peru, August 2–5, 1883 (MacFarlane); and by August 18, at Arauca, Chile (Sharpe).

The Hudsonian curlew has been noted at St. Michael, Alaska, as late as September 2, 1899 (Bishop); Morro Bay, California, November, 1891 (Nelson); Great Bear Lake, August 30, 1903 (Preble); near Cape Churchill, Hudson Bay, August 24, 1900 (Preble); Henley Harbor, Ungava, August 27, 1860 (Coues). Near Newport, R. I., a gunner secured 30 birds in eight years on dates ranging from August 26, 1867, to October 2, 1874 (Sturtevant). Barbuda, West Indies, November 12, 1903 (specimen in United States National Museum).

Eskimo Curlew. *Numenius borealis* (Forst.).

Breeding range.—The principal summer home of the Eskimo curlew was on the barren grounds of Mackenzie, from near the Arctic coast (MacFarlane) south to Point Lake (Richardson). Thence a few ranged west as far as Point Barrow (Murdoch), but no nests seem to have been found west of Mackenzie.

Winter range.—Most of the species wintered in the campos region of Argentina (Sclater and Hudson) and Patagonia, south at least to the Chubut Valley (Durnford). It has been taken once on the Falkland Islands (Abbott). It was rare in Chile, south to Chiloe (Philippi). At present there are no data to determine the northern limit in winter, but probably few if any wintered much north of Buenos Aires.

Migration route.—The curlew left the Barren Grounds in the fall and went southeast to Labrador (Coues), where they gorged themselves for several weeks and became extremely fat. Then they passed across the Gulf of St. Lawrence and struck out to sea heading for the Lesser Antilles, nearly 2,000 miles distant. Some flocks stopped for a few days at the Bermudas (Jardine), but if the weather was fair the larger number passed on, flying both day and night, and did not land during the whole trip. When storms interfered, the birds were sometimes driven out of their course and appeared in considerable numbers on the coast of Massachusetts (Mackay) and less often on Long Island (Giraud) and the New Jersey coast (Turnbull). The Eskimo curlew was absent, except as a straggler, from the whole coast of the United States south of New Jersey, from the Bahamas and from the Greater Antilles. In its southward flight it passed through the Lesser Antilles (Feilden) and along the eastern portion of Brazil (Pelzeln) to its winter home. Throughout the whole line of its fall migration it was unknown in spring, at which season it was traveling northward some thousands of miles farther west over the prairies of the Mississippi Valley. The exact route between its winter home and the United States is unknown, for along the whole 4,000 miles from Argentina to northern Mexico and southern Texas the species has been recorded only twice—once in Costa Rica (Zeledon) and once in Guatemala (Salvin). Its principal migration route in spring was a comparatively narrow belt crossing the prairies on both sides of the meridian of 97°. The course is well known from southern Texas (Merrill) to southern South Dakota (Agersborg) and thence data are wanting. There seem to be no records of the species from about latitude 44° in the Mississippi Valley until Great Slave Lake is reached, a thousand miles to the northward.

This curlew is unknown in the Rocky Mountain States or anywhere on the Pacific slope or coast south of Alaska, and the specimen taken April 8, 1892, at Lake Palomas, Chihuahua (specimen in United States National Museum), was far out of the usual course of the species. The species has been taken a few times in western Alaska, south to St. Michael (Nelson) and west to the Pribilof Islands (Palmer) and Bering Sea (specimen in United States National Museum). It has occurred accidentally several times in Europe and on the western coast of Greenland, north to Disco Bay (Winge).

Spring migration.—The Eskimo curlew arrived in Texas in March—Boerne, March 9, 1880 (Brown); Gainesville, average March 17, earliest March 7, 1884 (Ragsdale); and reached central Kansas about the middle of April—April 14, 1884 (Kellogg); April 13, 1885 (Kellogg). Most of the records in the central Mississippi Valley are in April. One of the latest and most northern is that of Coues, who says that he saw them in large flocks the second week in May, 1873, between Fort Randall and Yankton, S. Dak. Then there is no further news of them until they arrived at Fort Resolution, Mackenzie, May 27, 1860 (Kennicott); Fort Anderson, May 27, 1865 (MacFarlane); Point Barrow, May 20, 1882 (Murdoch).

Eggs were taken at Point Lake, Mackenzie, June 13, 1822 (Richardson), and on the Barren Grounds near Fort Anderson, June 13, 1863, June 16, 1864, and June 16, 1865 (MacFarlane).

Fall migration.—The Eskimo curlew started so early in August that by the middle of the month the old birds reached the eastern shores of Labrador (Coues). During the following two weeks they crossed the Gulf of St. Lawrence and made their long ocean flight and by the end of another fortnight they were at the winter home in Argentina (Sclater and Hudson). Dates of arrival along this course are: Indian Tickle Harbor, Labrador, August 16, 1860 (Coues); Houlton Harbor, Labrador, August 20, 1891 (Norton); Nantucket, Mass., average August 29, earliest August 18, 1898 (Mackay); Barbados, West Indies, August 27, 1886 (Manning); Amazon River, September 4, 1830 (Pelzeln); Concepcion, Argentina, September 9, 1880 (Barrows). Some dates of the last seen are: Fort Churchill, Keewatin, September 1, 1884 (Bell); Newfoundland, to end of September (Reeks); Saybrook, Conn., October 13, 1874 (Merriam); Barbados, West Indies, November 4, 1886 (Manning). Many curlews migrated south along the west coast of Hudson Bay, before they turned east to the Atlantic and some of these seem to have wandered occasionally southward and given rise to such records as Kingston, Ontario, October 10, 1873 (Fleming); Erie, Pa., September 17, 1889 (Sennett); and a few fall records around Lake Michigan.

The Eskimo curlew is rapidly approaching extinction, if indeed any still exist. In the early sixties MacFarlane found them breeding abundantly on the Barren Grounds near Fort Anderson, while Coues reports thousands passing south along the Labrador coast in the fall; in the early seventies Coues found them equally abundant passing north through South Dakota in the spring. Ten years later they were still common in their winter home in Argentina, and naturalists who visited the Labrador coast at this time record them as present in flocks but not in numbers as seen by Coues. By 1889 only a few flocks were seen, and within the next half dozen years the flights ceased. During the last fifteen years the species has been recorded only a few times and apparently only three times in the ten years previous to 1909: Tuckernuck Island, Massachusetts, eight birds August 24, 1897 (Mackay); Nantucket, Mass., two, August 18, 1898 (Mackay); northeastern coast of Labrador, about a dozen the fall of 1900 (Bigelow). The latest records are those of two birds shot August 27, 1908, at Newburyport, Mass. (Thayer), and one September 2, 1909, at Hog Island, Maine (Knight). The disappearance of the Eskimo curlew has given rise to much speculation as to the probable cause. A simple explanation is that during recent years, especially since 1880, its former winter home in Argentina has been settled and cultivated, while its spring feeding grounds in Nebraska and South Dakota have been converted into farm land.

[**European Curlew.** *Numenius arquatus* (Linn.).

This Eastern Hemisphere species breeds from Great Britain to southern Russia, the White Sea, and the Ural Mountains. It winters in Great Britain and occurs at this season from the Mediterranean to the south end of Africa.

It is probable that one specimen of this curlew was collected on Long Island in 1853—its only North American record.]

Whimbrel. *Numenius phæopus* (Linn.).

Though an Old World species, the whimbrel is a common visitor in Greenland (Schalow) and possibly breeds there. It breeds in Iceland, Scandinavia, and Russia, east to the Ural Mountains and north to the Arctic Circle. It winters on the coast and islands of tropical and southern Africa, and ranges at this season east to India and the Malay Peninsula. One was taken May 23, 1906, about latitude 43° N. and longitude 60° W., south of Sable Island, Nova Scotia (Brewster).

Bristle-thighed Curlew. *Numenius tahitiensis* (Gmel.).

The breeding range of this species has not yet been ascertained, but in Alaska it has been taken May 18, 1869, on the Kenai Peninsula (Bischoff); May 24, 1880, at St. Michael (Nelson); August 26, 1885, on the Kowak River (Townsend); and May 23, 1905, at the head of Nome River (Anthony). These dates would seem to indicate that the species nests in the northern part of its range.

The species is common on the Hawaiian Islands and occurs throughout the islands of the Pacific south to New Caledonia and from the Ladrones to the Marquesas and Paumota islands. The Pacific islands seem to be the winter home of the species, and on some of them it is quite common. It has been taken in the Phoenix group near the equator in June and July, and a few are known to remain all summer in Hawaii (Henshaw), but these apparently are nonbreeding birds.

Lapwing. *Vanellus vanellus* (Linn.).

Though an Old World species, the lapwing has been noted several times in Greenland on the west coast from Julianehaab to Godthaab, at various times from early December to the first of April (Schalow). It has been taken as a straggler at White Hills, Newfoundland, November 23, 1905 (Brewster); Halifax, Nova Scotia, March 17, 1897 (Piers); Merrick, Long Island, about December 26, 1883 (Dutcher); Meccox Bay, Long Island, fall of 1905 (Beebe); Hog Island, Bahamas, November, 1900 (Fleming); Barbados, 1886 (Cory).

The breeding range extends from Great Britain to Japan, from central Europe to the Arctic Circle, and from northern China to about latitude 55° in Siberia. The species winters from about the southern limit of the breeding range to northern Africa and southern China.

Dotterel. *Eudromias morinellus* (Linn.).

This is an accidental visitor to North America, the only record being that of one taken July 23, 1897, on King Island, Alaska (Stone). It breeds from Great Britain, southern Russia, and eastern Siberia north to the islands of the Arctic coast. It winters from southern Europe to equatorial Africa.

Black-bellied Plover. *Squatarola squatarola* (Linn.).

Breeding range.—This is a circumpolar species, but the places where it is known to breed are comparatively few. In North America it has been found breeding on the Melville Peninsula (Richardson), Boothia Felix (Ross), Franklin Bay (MacFarlane), and Point Barrow (Murdoch). In the Eastern Hemisphere it breeds on the Kolgnjef and Dolgoi islands of Russia and near the Taimyr Peninsula, Siberia, and probably breeds on the Liakoff Islands, Siberia, and near the south end of Nova Zembla Island.

Winter range.—The North American breeding birds pass south in winter to Chimbote and Tumbez, in northern Peru (Taczanowski), and to the Amazon River, Brazil (Pelzeln). The species is also found at this season through northern South America, the West Indies, Central America, and Mexico to the coast of South Carolina (Coues), occasionally North Carolina (Bishop), southern Texas (Sennett), and the coast of California north to Humboldt County (Townsend). It probably wintered formerly to the mouth of the Columbia (Suckley). The birds of Russia and Siberia winter from the Mediterranean, India, and southern China to southern Africa and Australia. The species is accidental in Hawaii (Henshaw).

Migration range.—The black-bellied plover has been taken several times on the west coast of Greenland north to Egedesminde, latitude 69° N. (Winge), but probably does not breed in that country. It is known only as a migrant along the east coast of Siberia, as at Plover Bay (Nelson) and on the Commander Islands (Stejneger).

Spring migration.—The species is a late and not common migrant on the Atlantic coast in the spring, and appears in New Jersey (Stone) and on Long Island in late April and early May; Montauk, N. Y., April 30, 1902 (Scott); Cape Cod, Massachusetts, average May 23, earliest April 18, 1894 (Mackay); Pictou, Nova Scotia, May 17, 1895 (Hickman). Nor is it common in the interior, where some dates of spring arrivals are: Near New Orleans, La., March 2, 1890 (Beyer); Sedalia, Mo., March 21, 1884 (Sampson); southern Ontario, average May 27, earliest May 22 (Fleming); Vermilion, S. Dak., May 3, 1884 (Agersborg); northern North Dakota, average May 8, earliest May 5, 1894 (Bowen); Reaburn, Manitoba, average May 19, earliest May 14, 1901 (Wemyss); Cheyenne, Wyo., average May 18, earliest May 11, 1884 (Bond); Indian Head, Saskatchewan, average May 14, earliest May 9, 1904 (Lang); Fort Chipewyan, Alberta, May 23, 1901 (Preble); Fort Resolution, Mackenzie, June 2, 1860 (Kennicott); Sitka, Alaska, May 6, 1869 (Bischoff); mouth of the Yukon, May 12; Dawson, Yukon, May 20, 1899 (Bishop); Point Barrow, Alaska, June 21, 1882 (Murdoch), and June 26, 1898 (Stone).

Some individuals remain late in the spring on the Atlantic coast and possibly some nonbreeders may remain the entire summer. In Florida they have been seen June 14, June 29, July 4, July 26, and

August 3 (Scott and Worthington). They have been seen in Jamaica in June (Field), and even off the coast of Venezuela they were common June 21–27, 1892 (Hartert). The last of the regular migrants do not leave the coast of Massachusetts until June—average June 6, latest June 15, 1886 (Cahoon); Western Egg Rock, Maine, June 24, 1895 (Knight); Toronto, Ontario, June 2 (Fleming); Corpus Christi, Tex., July 1, 1887 (Sennett).

Eggs were taken at Franklin Bay, Mackenzie, July 4, 1864, and July 8, 1865 (MacFarlane), but in each case the eggs were already partly incubated.

Fall migration.—The southward movement begins early in July, bringing a few individuals into the United States the latter part of that month—eastern Massachusetts, July 8 (Howe and Allen); Toronto, Ontario, July 23, 1890 (Fleming)—but the regular migration occurs in August: Cape Cod, Massachusetts, average August 17, earliest August 6 (Mackay); Long Island, New York, average August 6, earliest July 1, 1905 (Kobbe); Erie, Pa., August 1, 1890 (Todd); southern Wisconsin, August 10, 1872 (Kumlien and Hollister); southern British Columbia, August 15, 1903 (Brooks). The last were seen at Winter Island on the coast of Melville Peninsula August 17, 1821 (Greely), and the first flocks came along the Labrador coast August 15, 1860 (Coues). The species was unusually abundant on Prince Edward Island in 1892 from August 22 to September 14 (Mackay). Some dates of the last seen are: Point Barrow, Alaska, August 20, 1897 (Stone); Great Bear Lake, Mackenzie, September 5, 1903 (Preble); St. Michael, Alaska, September 16, 1899 (Bishop); southern British Columbia, October 23, 1888 (Brooks); Fort Collins, Colo., October 28, 1893 (Cooke); Lincoln, Nebr., October 21, 1899 (Wolcott); Ottawa, Ontario, average October 24, latest November 8, 1903 (White); Pictou, Nova Scotia, October 11, 1894 (Hickman); Cape Cod, Massachusetts, average October 21, latest November 14, 1887 (Cahoon)—accidental in December, 1872 (Mackay); Erie, Pa., November 10, 1894 (Todd); Long Island, New York, average October 15, latest November 7, 1905 (Latham).

European Golden Plover. *Charadrius apricarius* Linn.

The combined ranges of the three golden plovers complete the circumference of the globe in the vicinity of the Arctic Circle. In general it may be said that *apricarius* breeds in northern Europe and northwestern Siberia; *dominicus* in North America; and *fulvus* in eastern Siberia. The ranges of *apricarius* and *dominicus* meet on the west coast of Greenland; *dominicus* and *fulvus* join ranges in western Alaska; the dividing line in Siberia between *fulvus* and *apricarius* has not yet been determined.

The European golden plover breeds from Great Britain to western Siberia and south to central Europe. It winters from about the southern limit of the breeding range south to Beluchistan and northern Africa. This plover has been taken as a summer visitor to the east coast of Greenland (Helms), and at several places on the west coast from the southern end to Christianshaab about 69° latitude (Winge). It has not yet been found breeding in Greenland, though it has been taken there in midsummer (Helms).

Golden Plover. *Charadrius dominicus* Müll.

Breeding range.—The summer home of the golden plover extends from Whale Point at the northwest corner of Hudson Bay (Eifrig), west across the barren grounds to the mouth of the Anderson River (MacFarlane), and thence along the barren grounds of the coast of Alaska to Kotzebue Sound (Grinnell). It extends north in Franklin to include the islands, at least as far as latitude 77°. The bird is known to breed commonly on Banks Island (Armstrong), Prince Albert Island (Armstrong), Melville Island (Parry), and the islands at the north end of Wellington Channel (Belcher), and east to the eastern coast of Melville Peninsula (Parry). It probably does not breed in Greenland, though it occurs not uncommonly on the west coast to about latitude 73° (Walker). There are somewhat doubtful records of the species having been seen August 7, 1881, at Cape Baird, Lady Franklin Bay, 81° 30′ N. (Greely), and on July 12, 1872, at Thank God Harbor, Greenland, 81° 40′ (Davis). As the belt of tundra along the north coast of Alaska is comparatively narrow, the principal breeding grounds of the golden plover are between the mouth of the Mackenzie River and the Gulf of Boothia, north of the Arctic Circle.

Winter range.—The species ranges south on the Atlantic coast to Bahia Blanca, central Argentina (Barrows), and the center of abundance during the winter season is the pampas of Argentina (Sclater and Hudson) and Uruguay (Aplin), between the parallels of 34° and 36° S. Individuals remain during the winter as far north as Rio Janeiro, Brazil (Hapgood), on the coast and to Cuyaba, Matto Grosso (Pelzeln), in the interior. There is one record of the occurrence of the species (probably casual) in January at Nauta in northeastern Peru (Sharpe). The golden plover does not winter in the Lesser Antilles nor in that part of northeastern South America where it is most abundant in migration. It has been recorded as wintering at several places north of South America, but probably such of these records as are not errors represent accidental or unusual occurrences.

Migration range.—From the breeding grounds the golden plover go south and southeast to Labrador; then cross the Gulf of St. Lawrence and its islands to Nova Scotia, and from the southern coast of the latter fly directly across the ocean to the Lesser Antilles and the coast of northeastern South America. Sometimes when caught by a storm during this flight they seek the nearest land, appearing not infrequently at the Bermudas, Cape Cod, and Long Island. After a short stop in the Antilles and northern South America, they pass to the winter home in Argentina and remain there from September to March.

The return northward in spring is by a different route, the details of which are not yet determined. What is known is that they disappear from Argentina and shun the whole Atlantic coast from Brazil to Labrador. In March they appear in Guatemala and Texas; April finds them on the prairies of the Mississippi Valley; the first of May sees them crossing our northern boundary; and by the first week in June they reappear on their breeding grounds in the frozen north.

Various theories have been advanced to account for this strange migration course. The simplest explanation seems to be the application of the following, which may be laid down as the fundamental law underlying the choice of migration routes. Birds follow that route between the winter and summer homes that is the shortest and at the same time furnishes an abundant food supply. Applying this rule to the case of the golden plover, the following facts are apparent: The plover is a bird of treeless regions; it summers on the tundras and winters on the pampas; an enormous food supply especially palatable tempts it in the fall to Labrador and furnishes power for the long flight to South America. To attempt to return in spring by the same course would be suicidal, for at that season Labrador would furnish scant provender. The plover seeks the shortest treeless route overland, and alighting on the coast of Texas travels leisurely over the Mississippi Valley prairies, which are abundantly supplied with food, to the plains of the Saskatchewan and thence to the Arctic coast.

Spring migration.—The principal line of migration from the winter home northward through South America is not yet known; the species is said to be common in March and April in Peru (Sclater and Salvin) east of the mountains, but next to nothing is known regarding its appearance in the territory for a thousand miles to the northward. The species is practically unrecorded at all seasons of the year from Ecuador, Colombia, Panama, Nicaragua, and Honduras, and though a few have been noted in Costa Rica (Cherrie), Guatemala (Sclater and Salvin), and eastern Mexico (Sclater), in none of these countries have the great flocks been seen that are so characteristic of the fall flight in the Lesser Antilles and of the spring advance up the Mississippi Valley. Not until Texas is reached can the movements of the golden plover be definitely traced, and at no place between Peru and Texas has it ever been recorded as common. In fact, the records as they stand are what they should be if the plover escapes the forested regions of northern South America and Central America by a single flight of from 2,000 to 2,500 miles from the valleys of eastern Peru to the treeless prairies of Texas. The general time of appearance in the

United States and of passage to the summer home can be gathered from the following dates of arrival: Boerne, Tex., March 9, 1880 (Brown); Indianola, Tex., March 15, 1856 (Cassin); Gainesville, Tex., March 17, 1885 (Ragsdale); Caddo, Okla., March 12, 1884 (Cooke); near New Orleans, La., March 24, 1894 (Allison), April 2, 1881 (Langdon); Fayetteville, Ark., abundant March 20–31, 1883 (Harvey); central Missouri, average April 13, earliest April 11, 1903 (Bryant); Badger, Nebr., average April 8, earliest April 5, 1903 (Colt); Lebanon, Ill., March 17, 1876 (Jones); Tampico, Ill., average April 10, earliest March 31, 1885 (Brown); Terre Haute, Ind., March 23, 1888 (Evermann); Chicago, Ill., average April 16, earliest March 30, 1899 (Gault); central Iowa, average April 19, earliest April 12, 1883 (Williams); Heron Lake, Minnesota, average May 1 (Miller); central South Dakota, average April 30, earliest April 25, 1888 (Bishop); Larimore, N. Dak., average May 5, earliest May 2, 1895 (Eastgate); Aweme, Manitoba, average May 4, earliest April 23, 1905 (Criddle); Indian Head, Saskatchewan, May 9, 1904 (Lang); Fort Simpson, Mackenzie, May 26, 1860 (Ross), May 19, 1904 (Preble); Fort Reliance, Yukon, May 13 (Nelson); Point Barrow, Alaska, latitude 71° N., May 21, 1882 (Murdoch), May 24, 1883 (Murdoch), June 1, 1898 (Stone). The dates of arrival in the province of Franklin are: Igloolik, 69°, June 14, 1823 (Parry); Boothia Felix, 70°, June 4, 1830 (Ross), June 22, 1831 (Ross); Prince of Wales Strait, 73°, June 7, 1851 (Armstrong); Bay of Mercy, 74°, June 3, 1852 (Armstrong); Winter Harbor, 75°, June 2, 1820 (Parry); near Wellington Channel, 77°, June 2, 1853 (Belcher).

The latest dates recorded in the southern part of the winter range are March 12 (Aplin) and March 19 (Barrows); in the northern part of the winter home the species remains until April (Sclater and Salvin); at Chicago the average date of the last one seen is April 30, and the latest May 9, 1895 (Blackwelder). Some other late dates are: Near New Orleans, La., June 10, 1907 (Kopman); Lebanon, Ind., May 10, 1894 (Beasley); Lawrence, Kans., May 8, 1906 (Wetmore); White, S. Dak., May 27, 1889 (Partch); Aweme, Manitoba, average May 23, latest May 29, 1896 (Criddle); Fort Chipewyan, Alberta, June 1, 1893 (Russell). South of the latitude of Chicago the bulk of the spring shooting of golden plover is in April; from Iowa northward to Canada the spring shooting occurs chiefly during the first half of May.

During the spring migration the golden plover is almost entirely absent from the Atlantic coast. There are three spring records for Massachusetts (Mackay) and a few for Long Island (Giraud), the last of them many years ago. Probably most of the other scattered spring records east of the Alleghenies are errors of identification. The species is not common at any time of the year west of Texas, Nebraska, and Saskatchewan, and apparently is absent in spring from the whole region west of the Rocky Mountains.

Eggs were collected on the lower Anderson River, Mackenzie, June 24, 1863, June 22, 1864, and June 16, 1865 (MacFarlane); at Point Barrow, Alaska, June 22, 1882, and June 23, 1883 (Murdoch).

Fall migration.—The old birds start south in July, and those that are to make the flight from Nova Scotia to the Lesser Antilles occupy about a month in the trip from the breeding grounds to the southern coast of Nova Scotia. If fair weather prevails, the flocks of golden plover pass by the New England coast far out at sea, but severe storms are frequent at this season, and the birds are often driven to land. The average for twenty-eight years of the date of arrival of these storm-driven migrants at Nantucket, Mass., is August 25, earliest August 12, 1898 (Mackay); a still earlier date is August 7, 1852, at Plymouth, Mass. (Browne). Five times in these twenty-eight years birds were seen before August 20 (Mackay). The rule on Long Island is to expect the plover with the first storm occurring after August 28 (Lawrence). The first flocks are noted in the Bermudas during the last ten days of August (Reid), and about the same time the species arrives in the Lesser Antilles (Lawrence) and even on the coast of British Guiana (Quelch). A few golden plover reach Argentina the last week in August (Sclater and Hudson) and the species has been taken in Bolivia in August (Allen), but these early couriers are exceptional, and the main flocks arrive in September.

On the west side of Baffin Bay in 1820 the last was seen September 3 (Parry); in Nova Scotia the species sometimes remains until October (McKinlay). The average date of the last one seen at Nantucket, Mass., for ten years previous to 1890 is October 2, latest October 22, 1878 (Mackay); for the years since 1890 the average date of the last seen is September 23 (Mackay). Near Newport, R. I., a market hunter shot 386 golden plover during 1867 to 1874; the dates ranged from August 14, 1868, to October 24, 1874 (Sturtevant). On Long Island the dates of the earliest and latest recorded observations of the species are August 15 and November 10 (Chapman). In the Bermudas and the Lesser Antilles most of the birds leave in October, though some stragglers may be noted in November.

In the interior of New England the golden plover is rare in fall, though at times it is quite common on Lake Champlain. Throughout New York, Pennsylvania, and New Jersey it is usually very rare, but in 1880 and in several other years it has been common in those States. It has been seen at Erie, Pa., on dates ranging from August 20, 1896, to November 18, 1900 (Todd). South of New Jersey on the Atlantic coast, also in the Bahamas, the golden plover is almost unknown, and it is not common anywhere in the Greater Antilles west of St. Croix.

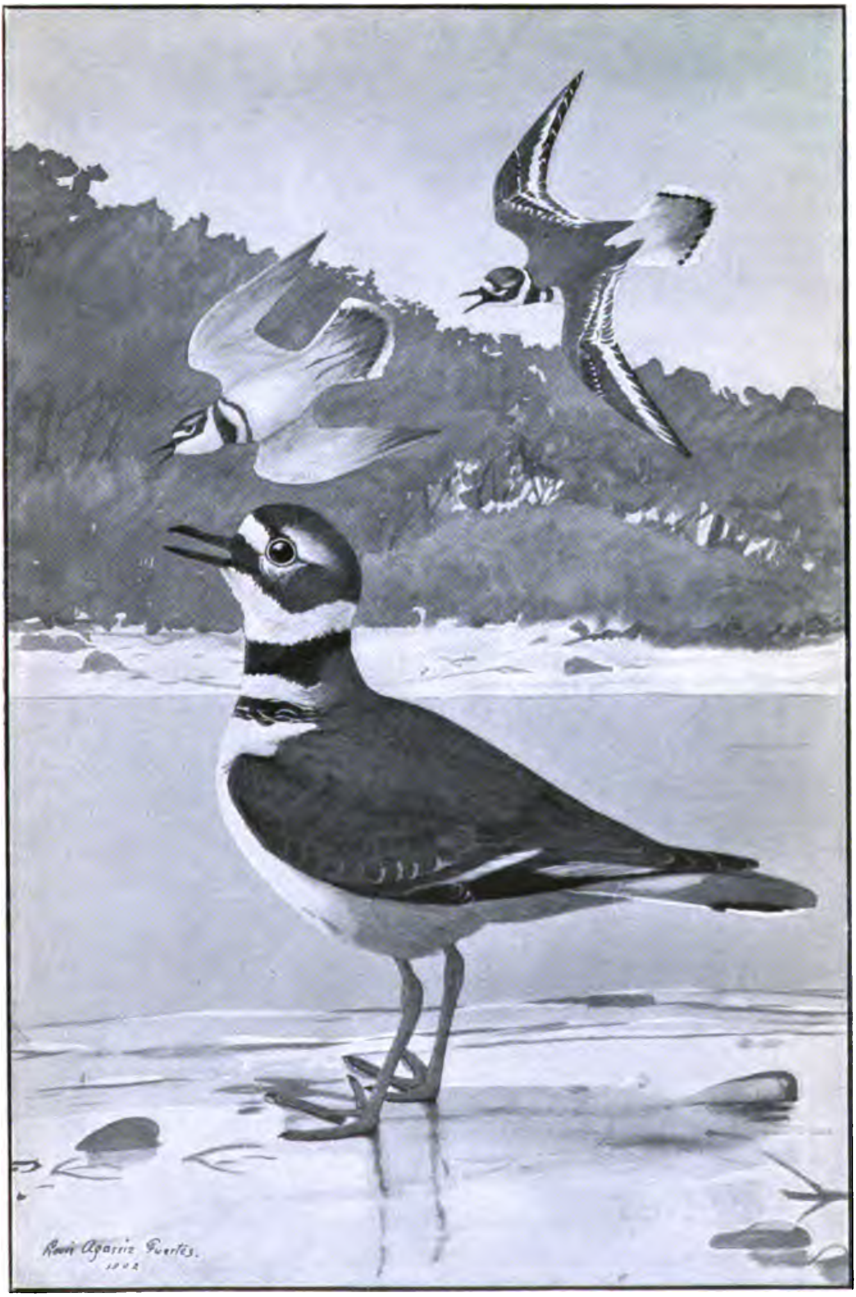
While the greater number of golden plover migrate across the Atlantic, a few pass south in the fall through the interior of North America. The first arrival from the north noted near Fort Churchill, Keewatin, in 1900, was on August 4 (Preble). Other dates of fall arrival in the interior are: Moose Factory, Ontario, September 8, 1860 (Drexler); Aweme, Manitoba, average September 9, earliest August 10, 1904 (Criddle); Lincoln, Nebr., September 22, 1900 (Wolcott); near Toronto, Ontario, August 31, 1891 (Nash), September 1, 1898 (Nash); Point Pelee, Ontario, September 15, 1905 (Swales), September 19, 1906 (Taverner); Chicago, Ill., average September 12, earliest September 10, 1898 (Gault); Bay St. Louis, Miss., September 26, 1899 (Allison); San José, Costa Rica, October 20, 1890 (Cherrie). Probably these Mississippi Valley fall birds are the ones that are fairly common in Peru from September to November (Sclater and Salvin) and that were noted in October at Arica, Chile (MacFarlane).

The form of the golden plover that breeds on the northern and northwestern coasts of Alaska does not seem to migrate along the western coast of Alaska, but passes in general east to Mackenzie. A few individuals migrate southeast and occur in the fall as rare stragglers on the Pacific slope: Sitka, Alaska, August 16, 1896 (Grinnell); Chilliwack, British Columbia, August 26, 1889 (Brooks); Port Townsend, Wash., September 9, 1897 (Fisher); Santa Cruz, Calif., October 22, 1888 (McGregor); San José del Cabo, Lower California, October 18, 1887 (Brewster).

The golden plover does not remain late in the north. The last seen on the breeding grounds at Point Barrow, Alaska, were noted August 28, 1882 (Murdoch), and August 20, 1897 (Stone). Some other dates of late occurrence are: Great Bear Lake, September 6, 1903 (Preble); Fort Simpson, September 10, 1860 (Ross); Edmonton, Alberta, September 23, 1894 (Loring); Indian Head, Saskatchewan, October 2, 1904 (Lang); Aweme, Manitoba, average October 14, latest October 16, 1901 (Criddle); near Fort Pierre, S. Dak., October 21, 1855 (Cassin); Fort Sherman, Idaho, abundant September 15–20, 1896 (Merrill); Newcastle, Colo., October 5, 1902 (Bishop); Lincoln, Nebr., November 14, 1899 (Wolcott); Lanesboro, Minn., November 2, 1889 (Hvoslef); southern Iowa, average October 27, latest November 9, 1895 (Currier); Chicago, Ill., average October 11, latest October 28, 1895 (Blackwelder); English Lake, Ind., November 9, 1891, November 15, 1892 (Butler); Ottawa, Ontario, October 31, 1906 (White); city of Quebec, Canada, November 10, 1890 (Dionne); San José, Costa Rica, December 15, 1890 (Cherrie).

The golden plover is one of the shorebirds that has diminished most markedly during the last twenty years. Formerly it was enormously abundant, and many are the accounts of the countless flocks that passed in an almost continuous stream across the Gulf of

PLATE IV.



KILLDEER (OXYECHUS VOCIFERUS).

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St. Lawrence and out to sea. On the return up the Mississippi Valley also they were abundant. For the ten years 1895–1904 the numbers reported have been so small that the species seemed in imminent danger of extinction. During 1905 and 1906, however, the species was reported from quite a number of localities, indicating that at present the comparatively small number of individuals left are holding their own. The future of the American golden plover is in the hands of the sportsmen of the Mississippi Valley. During the breeding season the birds are out of reach of danger from mankind; through the winter their welfare is out of the control of the people of the United States; but in spring during their two thousand mile journey up the Mississippi Valley, for from six to eight weeks, great numbers are slaughtered, and as a result they have diminished to a small fraction of their former numbers. If the species is to hold its own spring shooting in the Mississippi Valley must be largely curtailed or entirely abolished.

Pacific Golden Plover. *Charadrius dominicus fulvus* Gmel.

The principal summer home of the Pacific golden plover is in Asia, where it breeds in northern Siberia east of the Yenisei River; it breeds also on the western coast of Alaska from near Bering Strait south to Bristol Bay. It winters on the Hawaiian Islands and in China and India and south to New Zealand and Australia. Early dates of arrival in Alaska are at Portage Bay, May 13, 1882 (Hartlaub); Kadiak Island, May 13, 1868 (Bischoff); Atka Island, May 17, 1879 (Turner). The usual time of arrival at the mouth of the Yukon is about the first of June, and the latest date in the fall is October 12 (Nelson).

Killdeer. *Oxyechus vociferus* (Linn.).

Breeding range.—The killdeer has one of the most extensive breeding ranges of the American shorebirds. It ranges north in summer to central Quebec (Merriam), northern Ontario (Todd), central Keewatin (Preble), southern Mackenzie (Preble), and to about latitude 53° in the interior of British Columbia. The killdeer was seen at Fort Churchill, Keewatin, and at Fort Resolution, Mackenzie, by parties of the Biological Survey, and these observations very materially extend its previously known northern range. The breeding range of the killdeer extends much farther south than that of other northern breeding shorebirds. The species breeds not only throughout the whole of the United States, but south to Cape St. Lucas, Lower California (Xantus), and to Rio Sestin, Durango (Miller). Killdeers occur in Newfoundland in the fall (Reeks), but are not known to breed on that island.

Winter range.—The winter range is much less extensive than the summer. Though there are records of the presence of the species in

Paraguay (Sharpe) and Chile (Salvin), it is probable that these represent casual occurrences and that regularly the species ranges to the Bermudas (Jardine), throughout the West Indies and the neighboring northern coast of Venezuela (Ernst), but not farther east or south on the Atlantic coast; while on the Pacific it regularly passes south to northwestern Peru (Sclater and Salvin) and the interior of Colombia and Medellin (Sclater and Salvin). The northern winter range extends regularly to North Carolina (Brimley), Tennessee (Gettys), central Texas (Brown), rarely southern Arizona (Mearns), and throughout most of the southern half of California (Fisher). Casual occurrences have been noted in Maryland (Stabler), Pennsylvania (Burns), and Rhode Island (Mearns). After the great storm of November, 1888, which carried large numbers of killdeer to the New England coast several weeks later than the usual time for their disappearance from that part of their range, many of these birds failed to undertake a second southward migration and remained on the coasts of Massachusetts (Torrey), New Hampshire (Chadbourne), and southwestern Maine (Brown). Most of them perished during the winter, but on the Massachusetts coast a few managed to endure. An occasional killdeer passes a mild winter in southern Ohio (Jones), southern Indiana (McAtee), or on the Pacific coast to Washington (Johnson).

Spring migration.—The killdeer is among the earliest migrants among shorebirds, and is not far behind the earliest migrating land birds. Its loud, piercing, oft-repeated calls make its identification easy, and many data have been accumulated concerning the time of its migrations. These begin in February in the northern part of the winter range, and during that month many crowd northward to the limit of unfrozen ground. Such birds arrive on the average near Asheville, N. C., February 22, earliest February 18, 1893 (Cairns); central Kentucky, February 25, earliest February 19, 1906 (Embody); Brookville, Ind., February 23, earliest February 15, 1890 (Butler). The early days of March find the killdeer in full migration far beyond its winter home, and its arrival has been noted as follows: Variety Mills, Va., average March 13, earliest March 2, 1888 (Micklem); White Sulphur Springs, W. Va., average March 9, earliest March 2 1891 (Surber); Washington, D. C., average March 18, earliest February 14, 1908 (Hollister); Waynesburg, Pa., average March 8, earliest February 24, 1891 (Jacobs); Berwyn, Pa., average March 14, earliest January 29, 1889 (Burns); Branchport, N. Y., average March 19, earliest March 1, 1890 (Burtch); Jewett City, Conn., average for twenty-one years March 17, earliest March 2, 1888 (Jennings); central Rhode Island, average March 19, earliest February 27, 1902. Even as far north as Rhode Island, the killdeer is so rare that a market gunner near Newport (Sturtevant) secured only three during eight years while shooting several thousand shorebirds.

There seems to be a section west of the Allegheny Mountains in which the killdeer arrives earlier than at corresponding latitudes either east or west. The average date of arrival at Waterloo, Ind., is March 5 (Link); Oberlin, Ohio, March 5 (Jones); Livonia, Mich., March 10 (Alexander); and Petersburg, Mich., March 10 (Trombly). Near there in Pennsylvania, on the western side of the mountains, the date of arrival at Waynesburg has already been given as March 8 (Jacobs). At the same latitude in Pennsylvania east of the mountains the killdeer arrives a week later, while to the westward of Indiana the retardation of migration is shown by the following dates of arrival: Central Missouri, average March 12, earliest February 4, 1890 (Bush); southern Iowa, average March 12, earliest March 2, 1906 (Davison); southern Wisconsin, average of thirty years March 15, earliest March 2, 1887 (Welman); Chicago, Ill., average of sixteen years March 21, earliest February 28, 1895 (Woodruff). Farther north in Ontario, as the killdeer nears the limit of its breeding range, the arrival is much delayed; southern Ontario is not reached on the average until March 23, earliest March 7, 1903 (Smith), while the average date at Ottawa, Ontario, is April 17, earliest March 18, 1894 (White). Dates of arrival farther west are: Manhattan, Kans., average March 8, earliest February 27, 1882 (Lantz); Onaga, Kans., average March 4, earliest February 23, 1891 (Crevecoeur); Syracuse, Nebr., average March 10, earliest February 26, 1902 (Hunter); central South Dakota, average March 24, earliest March 20, 1889 (Cheney); Lanesboro, Minn., average March 29, earliest March 13, 1889 (Hvoslef); Argusville, N. Dak., average April 7, earliest March 31, 1893 (Edwards); Larimore, N. Dak., average April 7, earliest April 3, 1893 (Eastgate); southern Manitoba, average April 5, earliest March 24, 1902 (Criddle); Qu'Appelle, Saskatchewan, average April 16, earliest April 8, 1903 (Wemyss); two seen June 25, 1903, at Fort Resolution, Mackenzie (Preble).

The advance in the Rocky Mountains is not so late comparatively as in most species: Cheyenne, Wyo., average March 21, earliest March 16, 1889 (Bond); Rathdrum, Idaho, average March 30, earliest February 19, 1902 (Danby); Terry, Mont., average April 6, earliest March 29, 1897 (Cameron); Big Sandy, Mont., average April 6, earliest April 3, 1904 (Coubeaux); Red Deer, Alberta, April 11, 1893 (Farley); Portland, Oreg., February 27, 1900 (Nicholas); Grays Harbor, Washington, February 16, 1892 (Lawrence); southern British Columbia, February 28, 1888 (Brooks). South of the breeding grounds the last was seen at San José, Costa Rica, March 12, 1890 (Cherrie), and at Sisal, Yucatan, May 9, 1865 (Schott).

The date of nesting seems to bear little relation to the latitude. Eggs have been taken at Cape St. Lucas, Lower California, May 9, 1860 (Xantus); Monterey, Calif., March, 1867 (Day and Spencer);

Variety Mills, Va., April 12, 1886 (Micklem); Laurel, Md., just hatching April 24, 1897; Erie, Pa., April 7, 1888 (Todd); Canandaigua, N. Y., April 23, 1879 (Howey); Bloomington, Ind., April 12, 1903 (McAtee); Kingston, Ontario, May 1, 1905 (Beaupre); Eagle Pass, Tex., March 18, 1884 (Negley); Corvallis, Oreg., downy young late April (Woodcock); Tacoma, Wash., April 14, 1908 (Bowles); Edmonton, Alberta, eggs May 19, 1897 (Macoun).

Fall migration.—The few records of fall arrival south of the breeding range show that the killdeer is one of the late migrants. It was noted in Porto Rico, October 18, 1899, and October 7, 1900 (Bowdish); San José, Costa Rica, October 15, 1891 (Cherrie); and on the coast of Peru, October 24, 1867 (Sclater and Salvin).

The last noted in southern British Columbia was November 28, 1888 (Brooks); Aweme, Manitoba, average September 23, latest September 30, 1901 (Criddle); Onaga, Kans., average October 22, latest November 8, 1896 (Crevecoeur); Lincoln, Nebr., latest November 18, 1900 (Wolcott); Delavan, Wis., November 6, 1894 (Hollister); southern Iowa, average November 10, latest December 25, 1886 (Houghton); Chicago, Ill., average October 21, latest November 13, 1885 (Holmes); southern Michigan, average November 1, latest November 13, 1891 (Alexander); Ottawa, Ontario, average September 11, latest October 16, 1905 (White); southern Ontario, average October 19, latest November 10, 1900 (Saunders); Wauseon, Ohio, average November 9, latest November 23, 1891 (Mikesel); Waterloo, Ind., average November 7, latest November 21, 1905 (Link); Montreal, Canada, September 1, 1895 (Wintle); Phillips, Me., October 24, 1905 (Sweet); Block Island, R. I., November 5, 1889 (Dodge); Branchport, N. Y., November 29, 1896 (Stone); Suffield, Conn., November 16, 1887 (Smith); Erie, Pa., November 26, 1891 (Todd); Berwyn, Pa., average November 3, latest November 22, 1886 (Burns); Bloomington, Ind., December 12, 1885 (McAtee); St. Louis, Mo., December 18, 1887 (Widmann).

[**Santo Domingo Killdeer.** *Oxyechus vociferus torquatus* (Linn.).

The Santo Domingo killdeer is the resident form of the West Indies, breeding in Cuba, the Isle of Pines, Jamaica, and Haiti, and probably also in Porto Rico.]

Semipalmated Plover. *Ægialitis semipalmata* (Bonap.).

Breeding range.—The present known summer home of the semipalmated plover extends north to Cumberland Sound (Kumlien), Melville Peninsula (Parry), Wellington Channel (Greely), and Melville Island (Parry). The occurrence of the species at these two latter places, latitude about 75° N., makes it probable that it occurs equally far north on the western side of Baffin Bay. It is common on the arctic coast of America as far west as the mouth of the Mackenzie (MacFarlane). Thence westward it seems to be rare on the northern coast of Alaska (Nelson), but is tolerably common in Kotzebue

Sound (Townsend). It seems to be more common in the middle Yukon Valley (Bishop) than on the coast.

This plover breeds south to Sable Island (Dodd); southern New Brunswick (Cheney); the Magdalen Islands (Brewster); southern James Bay (Todd); York Factory, in southern Keewatin (Preble); probably rarely in northern Manitoba (Macoun); on the Slave River of southern Mackenzie (Preble); Lake Marsh, southern Yukon (Bishop); and to the mouth of the Yukon, Alaska (Dall and Bannister).

Winter range.—The species winters on both coasts of South America—south to Port Desire, 48° S. (Seebohm), on the east coast, and to central Chile (Schalow) on the west; thence through northern South America, Central America, and the West Indies to the southern Bahamas (Bonhote), Florida (Worthington), the coast of Georgia (Helme), South Carolina (Kendall), Mississippi (Allison), and Louisiana (Beyer); on the Pacific coast of Mexico, north to southern Lower California (Brewster). In winter it is thus one of the most widely distributed of the shorebirds.

Migration range.—The species is a common migrant in eastern North America west to the eastern parts of Texas (Beckham), Nebraska (Wolcott), and Saskatchewan (Macoun). Thence over the plains and throughout the whole Rocky Mountain district it is almost unknown, but reappears on the Pacific Coast, and ranges west in migration to the central Aleutian Islands (McGregor), the Pribilof Islands (Prentiss), and even occasionally across Bering Strait to the coast of Siberia (Nelson).

Spring migration.—At least four-fifths of the dates on the spring migration of this species fall in May. This is true for the entire district between the winter and summer homes, and the dates indicate that the migration in the United States occurs chiefly between May 10 and June 1. An unusually early individual was taken April 7, 1875, at Erie, Pa. (Sennett). Other spring dates are: Magdalena Bay, Lower California, March 12, 1889 (Bryant); Monterey, Calif., April 17, 1903; Vancouver Island, British Columbia, April 28, 1894 (Kermode); Mount McKinley, Alaska, May 17, 1908 (Sheldon); Kowak River, Alaska, May 30, 1899 (Grinnell); Pea and Bodie islands, North Carolina, April 25, 1905 (Bishop); Lincoln, Nebr., April 27, 1900 (Wolcott); southern Ontario, average of six years May 18, earliest May 8, 1885 (Garnier); Melville Peninsula, May 31, 1882 (Parry); Wellington Channel, June 6, 1851 (Greely). The species was taken in Cuba as late as May 22, 1900 (Palmer and Riley); southern Florida, May 25, 1886 (Scott); from New Jersey to the Great Lakes it remains regularly to the first week in June—latest Oberlin, Ohio, June 17, 1904 (Jones); latest Worth, Ill., June 20, 1894 (Woodruff); and along the coast of Maine nonbreeders occur all summer (Knight).

Eggs have been taken at Grand Manan, New Brunswick, June 21, 1875 (Cheney); James Bay, June 18, 1896 (Macoun); Cape Fullerton, June 28, 1904 (Eifrig); Fort Anderson, June 11, 1863 (MacFarlane); Fort Yukon, Alaska, June 2, 1862 (Lockhart); Lake Marsh, Yukon, just hatched, July 2, 1899 (Bishop).

Fall migration.—At one of the most southern breeding places, near York Factory, Keewatin, in 1900, the most advanced young were still in the downy stage July 10 (Preble), and yet by this time the species is already in full fall migration, and the earliest individuals have appeared several hundred miles south of the breeding range: Toronto, Ontario, July 5, 1890 (Fleming); Rhode Island, July 6 (Howe and Sturtevant); Coronado de Terraba, Costa Rica, July 3, 1907 (Carriker); Margarita Island, off the coast of Venezuela, July 7, 1895 (Robinson). The regular fall migration is about a month later: Sitka, Alaska, common after July 25, 1896 (Grinnell); Prince Edward Island, average of three years August 13 (Bain); Long Island, New York, average of seven years August 6, earliest July 17, 1905 (Latham); Grenada, West Indies, August 24, 1881 (Wells); Santa Catarina, Brazil, August 4 (Sharpe).

Though most semipalmated plover migrate early, a few stay until freezing weather: Ottawa, Ontario, average of five years September 19, latest September 29, 1885 (White); Prince of Wales Sound, Ungava, latest September 25, 1886 (Payne); Prince Edward Island, average of three years, October 13 (Bain); Erie, Pa., rare after October 1, latest November 2, 1901 (Todd); Point Pelee, Ontario, October 29, 1905 (Taverner and Swales); Grinnell, Iowa, October 22, 1886 (Jones); Los Angeles County, Calif., October 17, 1894 (Grinnell).

Ringed Plover. *Ægialitis hiaticula* (Linn.).

Both coasts of Greenland are included in the breeding range of the ringed plover, from the southern end to Sabine Island (Scoresby) on the east coast and to McCormick Bay (Schalow) on the west. Across Smith Sound from this latter place and one degree farther north, at Buchanan Bay, Ellesmere Island, latitude 78° 48′ (Feilden) is the farthest north the species has been found in the Western Hemisphere, though north of Europe it has been taken at 83° latitude. On the American side it breeds south to Cumberland Sound (Kumlien); also south to central Europe and Turkestan, and east to the New Siberian Islands, and occurs casually east to the Chuckchi Peninsula. The winter is spent from the shores of the Mediterranean to southern Africa and rarely to northwestern India. It has wandered to Chile (Sharpe), and to Barbados, September 10, 1888 (Feilden). The first arrived at Cumberland Sound in 1878 about the middle of June (Kumlien).

Little Ringed Plover. *Ægialitis dubia* (Scop.).

The claim of the little ringed plover to a place among North American birds is rather slight. A specimen is supposed to have been taken on the coast of Alaska (Harting), and one is recorded from San Francisco, Calif. (Ridgway). In each case the bird was far from home, for the breeding grounds of the species are in southern Europe, central Asia, and north to about 60° latitude. The species winters in the northern half of Africa, and in Asia south to India, and the Malay Archipelago.

Piping Plover. *Ægialitis meloda* (Ord).

Breeding range.—The northern limit of the piping plover's breeding range is in Nova Scotia (Bryant), the Magdalen Islands in the Gulf of St. Lawrence (Bishop), southern Ontario (Saunders), central Manitoba (Bendire), southern Saskatchewan (Macoun), and probably southwestern Keewatin (King). It is very local in its distribution during the breeding season, and is unknown over most of the district mentioned above. Formerly it nested on the coast of Virginia at Cobbs Island (Kirkwood), and was fairly common as a breeder on the New Jersey coast (Scott). Now it is rare as a breeder anywhere on the Atlantic coast south of Nova Scotia, though still nesting at a few localities south to southern New Jersey (Stone). In the interior it nests as far south as Erie, Pa. (Todd); the lake shore in northern Ohio (Jones); near Lake Michigan in northwestern Indiana (Woodruff); and west to central Nebraska (Bruner, Wolcott, and Swenk).

Winter range.—The coast of Texas (Sennett) and the coasts of Florida (Scott) and Georgia (Worthington) constitute the principal winter home of this species. Indeed, it is probable that records at other places represent stragglers. The West Indies are commonly included in the winter range, but the species seems to be only casual in migration south of the United States. It was taken once in Porto Rico in August (Gundlach); Jamaica in November (Gosse); a few in Cuba in April of a single year (Gundlach); several on three islands of the Bahamas in May (Bangs) and July (Bonhite); three individuals in the Bermudas in the fall (Reid). It has occurred occasionally on the New Jersey coast in winter (Stone).

Spring migration.—Dates of spring arrival are very irregular. The average date on Long Island, New York, is April 7; earliest March 24, 1884 (Dutcher); eastern Massachusetts, average April 12, earliest March 26, 1893 (Mackay); southern Ontario, average May 16, earliest May 1, 1891 (Fleming). Some other dates of arrival are: Cumberland, Ga., March 10, 1902 (Helme); near Newport, R. I., March 24, 1903 (King); Erie, Pa., April 16, 1900 (Todd); Oberlin, Ohio, May 13, 1907 (Jones); Sioux City, Iowa, May 8, 1904 (Rich); Gibbon, Nebr., May 4, 1888 (Thatcher); Indian Head, Saskatchewan, May 16, 1892 (Macoun). Thus, in general, migration up the Mississippi Valley is much later than at corresponding latitudes on the

Atlantic coast. Stragglers were noted at Cheyenne, Wyo., May 30, 1892 (Bond), Julesburg, Colo., May 17, 1899 (Dawson), and Natashquan, Labrador, May 31, 1909 (Townsend and Bent).

Eggs have been taken at Big Charity Island, Michigan, May 20, 1903 (Arnold); Erie, Pa., May 24, 1900 (Todd); Long Beach, New Jersey, June 12, 1877 (Scott); Magdalen Island, June 16, 1897; Cedar Point, Ohio, June 26, 1903 (Jones); Miller, Ind., June 13, 1905 (Butler); Miner County, S. Dak., June 5, 1891 (Patton); near Indian Head, Saskatchewan, June 18, 1892 (Macoun). Downy young were taken July 21, 1906, at Big Stick Lake, southwestern Saskatchewan (Bent).

Fall migration.—The first was seen on the coast of North Carolina July 14, 1904 (Bishop); and at Fernandina, Fla., August 3, 1906 (Worthington). It was taken at Corpus Christi, Tex., all through July, 1887 (Sennett), but these may have been nonbreeders that summered on the coast. In general the species migrates so early that it is seldom found north of its winter home after August. Late dates are: Long Island, New York, August 30, 1889 (Scott); eastern Massachusetts, August 26, 1888 (Miller); Erie, Pa., September 26, 1902 (Todd).

Snowy Plover. *Ægialitis nivosa* Cass.

Breeding range.—The sea coasts and the shores of the larger lakes of western United States constitute the principal breeding grounds of the snowy plover. The species nests at least as far north as Pescadero, Calif. (Willard); Humboldt River, Nevada (Hanna); Salt Lake, Utah (Ridgway); Comanche County, Kans. (Goss); and on the coast of Texas (Sennett). It is extremely local in the interior. It breeds south at least to Corpus Christi, Tex. (Sennett), and probably along the northern third of the western coast of Lower California (Belding).

Winter range.—It winters in Chile south at least to Calbuco, latitude 41° S. (Schalow), and thence north in Peru (Sclater and Salvin), Guatemala (Salvin), and Mexico (Belding) to the coast of California at Santa Barbara (Keck). On the Atlantic side it winters as far north as Aransas Bay, Texas (Sennett).

Migration range.—Outside of the regular winter and summer homes, the species has been taken once in Brazil (specimen in United States National Museum); Margarita Island, off the coast of Venezuela, July 2, 1895 (Robinson); Guantanamo, Cuba, July, 1858 (Gundlach); Long Island, Bahamas, July 16, 1903 (Riley); Celestun, Yucatan, April 12, 1865 (Schott); Whitfield, Fla., May 5, 1903 (Worthington); Bay St. Louis, Miss., September 19–20, 1899 (Allison); Toronto, Ontario, twice (Fleming); Lincoln, Nebr., May 17, 1903 (Swenk); Cheyenne, Wyo., once (Bond); Newport, Oreg., March 24, 1906 (Shaw); Grays Harbor, Washington, September 3, 1899 (Dawson).

Spring migration.—The snowy plover was seen in Comanche County, Kans., May 12, 1887 (Goss), and at San Francisco, Calif., April 8, 1857 (Hepburn). The species has been taken at Cavanche, Chile, in May (Schalow), and at Coquimbo, Chile, in June (Sharpe). It may prove to be resident in Chile.

Eggs have been taken in Los Angeles County, Calif., April 25, 1899 (Robertson), and young, May 1, 1897 (Grinnell); also eggs at Santa Cruz, Calif., April 16, 1873 (Cooper). In southern Kansas the eggs are laid in late May (Goss).

Fall migration.—Fall migrants have been recorded in September from Guatemala (Salvin), and in October from the southern limit of the range in Chile (Schalow). The species has been taken at San Francisco as late as November 1, 1898 (Hornung).

Mongolian Plover. *Ægialitis mongola* (Pall.).

In the summer of 1849 Captain Moore of the *Plover* in his search for Sir John Franklin touched at the Choris Peninsula, Alaska, and while there secured two specimens of the Mongolian plover—the first and only individuals ever taken in North America. The breeding range of the species is on the opposite side of Bering Sea, on the Commander Islands, and in northeastern Siberia. It migrates through Japan and China, and winters from the Philippines to Australia.

[**Azara Ring Plover.** *Ægialitis collaris* (Vieill.).

The Azara ring plover is the only true shorebird found in Central America that does not range north to the United States. It has a wide distribution in South America, south to Argentina, extends north to southern Mexico, and has been taken once on Grenada, West Indies.]

Wilson Plover. *Ochthodromus wilsonius* (Ord).

Breeding range.—The Wilson plover is found in summer throughout the northern Bahamas (Bonhote) and along the Gulf coast of the United States from Florida (Scott) to Texas (Merrill), and breeds along the Atlantic coast at the present time as far north as the islands off the southeastern coast of Virginia (Dutcher); many years ago it bred occasionally on the New Jersey coast (Wilson). The summer status of the species on the Pacific coast of Lower California is not yet definitely settled. It was found common at Abreojos Point, June 17, 1897 (Kaeding), but whether or not it was breeding was not determined.

Winter range.—The winter range is not known with certainty, because the West Indies are occupied by a resident subspecies, *rufinuchus*, and sufficient material has not yet been accumulated to determine the relative areas occupied by the two forms in winter. The northern form winters as far north as southern Florida—formerly northern Florida (Scott); the coast of southern Texas (Merrill); Guaymas, Sonora (Nelson); and La Paz, Lower California (Belding). Thence it ranges south to the Pacific coast of Guatemala (Salvin).

Spring migration.—Dates of arrival on the Atlantic coast are: Amelia Island, Florida, April 2, 1906 (Worthington); Darien, Ga., March 19, 1890 (Worthington); Cumberland Island, Georgia, March 18, 1902 (Helme); Frogmore, S. C., March 26, 1886, and March 20, 1888 (Hoxie); Fort Macon, N. C., April 15, 1869 (Coues). The species has wandered north on the coast several times to Long Island (Dutcher), once to Connecticut (Purdie), once to Massachusetts (Coues), and even to Nova Scotia (Goss). The only record for the Pacific coast of the United States is that of the single bird taken June 29, 1894, at Pacific Beach, California (Ingersoll).

Eggs have been taken at Sarasota Bay, Florida, April 8 (Moore); coast of Georgia, April 29 (Bailey); Corpus Christi, Tex., April 25 (Chapman); Cobbs Island, Virginia, May 7 (Oates).

[**Rufous-naped Plover.** *Ochthodromus wilsonius rufinuchus* (Ridgw.).

The principal home of the subspecies rufous-naped plover is the Greater Antilles, whence it spreads to the neighboring coasts of British Honduras and Guatemala; probably also to Yucatan. It breeds also in northern South America on the coast of Colombia, Venezuela, and Guiana. While some individuals remain all the year on the breeding grounds, others migrate a short distance to several of the islands of the Lesser Antilles and to Brazil as far south as Bahia. It is probably this form that occurs on the coast of Ecuador and Peru, but from lack of specimens this point is not settled.]

Mountain Plover. *Podasocys montanus* (Towns.).

Breeding range.—The mountain plover seems to be confined in summer to the United States, but closely approaches the boundaries, both north and south. In 1874 it was found breeding and not uncommon on the Frenchman River in Montana (Coues), not far from the Canadian boundary, and on Milk River, Montana (Coues), right at the line, but so far has not been recorded anywhere in Canada. It breeds south to northern New Mexico (Henshaw); east to northwestern Texas (Bailey), western Kansas (Fisher), and western Nebraska (Bruner), west to Sun River, Montana (Dutcher), Fort Bridger, Wyo. (Drexler), Del Norte, Colo. (Hill and Orth), and San Miguel County, New Mexico (Mitchell).

Winter range.—This species winters from northern California (Cooper), southern Arizona (Osgood), and San Antonio, Tex. (Beckham), south to Zacatecas, Mexico (Sharpe), and La Paz, Lower California (Sharpe). It is one of the few species that winters farther west than it breeds.

Migration range.—The more eastern individuals of this species probably follow the usual north and south migration route, keeping to the plains east of the foothills of the Rocky Mountains, but some of the more western individuals take a very peculiar course in migration. The species is a tolerably common migrant at Marysville in northern California (Belding), arriving in November. Whence come these November birds? The nearest point of the breeding range is northwestern Montana in the vicinity of Great Falls (Williams). To reach Marysville from Great Falls the plover must pass through

Idaho and either Oregon or Nevada, but in these three States it is unknown, and seems not to be recorded from Utah. So the birds that visit California are separated from the nearest known habitat of the species by a zone about 600 miles wide and containing two ranges of high mountains.

Spring migration.—The mountain plover is among the early migrant shorebirds. It arrived on the average at Beloit, Colo., March 26, earliest March 23, 1890 (Hoskins); Loveland, Colo., March 18, 1887 (Smith).

Eggs have been taken at Fort Lyon, Colo., June 9, 1886 (Thorne); San Luis Valley, Colo., June 10, 1873 (Henshaw); young just hatched at Terry, Mont., June 15, 1898 (Cameron); young at Colby, Kans., June 28, 1893 (Fisher); eggs near North Platte, Nebr., July 8, 1859 (Suckley).

Fall migration.—The first was seen at Corpus Christi, Tex., July 25, 1887 (Sennett); Pecos City, Tex., August 1, 1903 (Ligon). Quite a party of them was seen at James Island, Florida, July 20 to August 1, 1901 (Williams), but they were probably only stragglers. The last one noted in 1890 at Beloit, Colo., was on October 15 (Hoskins).

Surf Bird. *Aphriza virgata* (Gmel.).

The breeding range of the surf bird is unknown, for the bird has never been encountered in its summer home. It goes north along the Pacific coast of the United States in spring, and has been traced all along the coast to the Kowak River, Alaska, where it arrived May 29, 1899 (Grinnell). Then it disappears and is not seen again until on its way south the latter part of July. The natives say it breeds on the mountains a few miles back from the coast.

The surf bird winters in Chile, as far south as the Strait of Magellan (Sharpe), and is known in migration on the coasts of Peru (Tschudi), Ecuador (Hartert), Mexico (Xantus), and Lower California (Kaeding). It arrived at Newport, Oreg., April 25, 1895; April 27, 1897; May 3, 1899; April 27, 1900; average of the four years April 28 (Bretherton). Agreeing well with this date is its appearance at San Geronimo Island, Lower California, March 15, 1897 (Kaeding); and the date already given of May 29 at Kowak River, Alaska (Grinnell). An extra early date is March 8, 1859, at Puget Sound, Washington (Kennerly). The latest recorded date at the Strait of Magellan is March 3, 1879 (Sharpe); the species was common at Abreojos Point, Lower California, April 19, 1897 (Kaeding); a belated bird was taken on the Farallon Islands, Calif., June 3, 1903 (Kaeding). Several appeared in fall migration at Sitka, Alaska, July 21 (Grinnell); Newport, Oreg., July 24, 1900 (Bretherton); Monterey Bay, Calif., August 3, 1894 (Loomis); Vaqueria, Ecuador, September 16, 1901 (Hartert). The species has been noted at St. Michael, Alaska, until the first of October (Nelson), and at Berkeley, Calif., as late as October 24, 1888 (Palmer).

Turnstone. *Arenaria interpres* (Linn.).

Breeding range.—The turnstone inhabits nearly the whole of the Eastern Hemisphere and a small part of the Western. It breeds along the whole Arctic coast of Europe and Asia and south to Japan and the islands in the Baltic Sea. It ranges eastward across Bering Strait at least to Point Barrow, Alaska (Stone), and breeds south to the mouth of the Yukon (Nelson) and on the islands of St. Lawrence (Nelson) and St. Matthew (Elliott) in Bering Sea. Its range to the northeastward in North America has not yet been definitely settled. Two specimens from the west coast of central Greenland have been identified by W. Palmer as *interpres.* No specimens were examined by him from any point between Greenland and the Anderson River, Mackenzie; the specimens from this latter place are certainly *morinella.* Where the dividing line between the two forms runs is not certain, but since the birds of eastern Ungava are *morinella,* it is probable that this is the form occurring on the islands near the Arctic coast of North America and equally probable that the records on the islands northwest of Greenland should be referred to *interpres.* The species has been recorded along the whole west coast of Greenland, and was found breeding at Disco Bay (Kumlien) and on the eastern and northern coasts of Ellesmere Island almost to latitude 83° (Feilden). The turnstone, therefore, is one of the most northern breeding of all birds. On the eastern coast of Greenland it ranges at least as far north as Sabine Island, latitude 74° (Winge).

Winter range.—The species winters on the coasts of nearly the whole of the Eastern Hemisphere from Europe and Asia to southern Africa, Australia, and the islands of the Pacific, Indian, and eastern Atlantic oceans.

Spring migration.—The species arrived in the Aleutians at Unalaska May 19, 1890 (Palmer). As it winters in Hawaii (Henshaw), and is not known on the coast of the mainland south of Alaska, it is practically certain that these Unalaska birds make the journey of 2,000 miles in a single flight from Hawaii to the Aleutians. Other dates of spring arrival are: Mouth of the Yukon, May 19, 1879 (Nelson); Nulato, Alaska, May 23, 1868 (Dall); Point Barrow, Alaska, June 12, 1882 (Murdoch), June 12, 1883 (Murdoch), and May 29, 1898 (Stone). The dates of arrival northwest of Greenland are May 27, 1876, at Cape Henry (Hart), and June 2, 1883, at Cape Baird (Greely), each near latitude 82°.

Eggs were taken July 30, 1876, at Discovery Bay, Ellesmere Island, 81° 40′ N. (Hart), and young were already on the wing July 9, 1883, at Fort Conger (Greely), a few miles distant. Downy young were taken June 4, 1898, at Point Barrow, Alaska (Stone).

Fall migration.—The first arrived on the Pribilof Islands July 2 (Elliott), and after the middle of the month were abundant. The last ones noted were: Depot Point, Ellesmere Island, latitude 82° 45′ N., September 11, 1875 (Feilden); Point Barrow, Alaska, August 29, 1882 (Murdoch), and September 4, 1897 (Stone); Nushagak, Alaska, September 21, 1902 (Osgood). A specimen is reported taken September 8, 1904, at Pacific Beach, Calif. (Bishop), and one September 8, 1892, on Monomoy Island, Massachusetts (Bishop).

Ruddy Turnstone. *Arenaria interpres morinella* (Linn.).

Breeding range.—Undoubted breeding records of the ruddy turnstone are very rare. It nested on the Lower Anderson and Franklin Bay (MacFarlane), and specimens of the breeding birds have been identified as *morinella*. Some form of the turnstone, probably *morinella*, breeds on Melville Island (Sabine), on Melville Peninsula (Parry), and at Bellot Strait (Walker), but its identity has yet to be determined by the examination of specimens.

Winter range.—The turnstone of the Western Hemisphere ranges south in winter to central Chile—at least to Talcahuano (Sharpe) and probably to Valdivia (Boeck)—and to Sao Paulo in Brazil (Ihering). It winters on the coasts of northern South America, in the West Indies, Central America, Mexico, and north to the coast of South Carolina (Coues), Louisiana (Beyer), Texas (Merrill), and in California at least as far north as San Francisco (Mailliard).

Spring migration.—The turnstone, notwithstanding it winters so far north, is a late migrant. The probable explanation is that its breeding grounds in the far north are not ready for occupancy until nearly midsummer. It was seen May 7, 1906, on Pea and Bodie islands, North Carolina (Bishop). The average date of arrival on Long Island, New York, is May 16, earliest May 12, 1897 (Scott); eastern Massachusetts, May 5, earliest May 1, 1892 (Mackay); Erie, Pa., May 24, 1893 (Todd). It appears to be rare in spring north of Maine on the Atlantic coast.

The species is rare in the interior of the United States, but has been noted a few times in nearly every State east of the Rocky Mountains. Some dates of arrival are: Starke County, Ind., May 20, 1888 (Butler); Oberlin, Ohio, May 16, 1901 (Jones); southern Ontario, average May 27, earliest May 24, 1900 (Nash); Leech Lake, Minn., May 24, 1903 (Currier); Indian Head, Saskatchewan, May 15, 1892 (Macoun); Fort Chipewyan, Alberta, May 25, 1901 (Preble); Fort Resolution, Mackenzie, June 1, 1860 (Kennicott); Fort Simpson, Mackenzie, May 29, 1904 (Preble); Fort Anderson, Mackenzie, June 10, 1864 (MacFarlane); Winter Island, Melville Peninsula, June 14, 1822 (Richardson).

It was found off the coast of Venezuela, July 2, 1892 (Hartert), July 7, 1895 (Robinson), and early July, 1901 (Clark). A few are said to remain all summer on Carriacou Island, West Indies (Wells).

The migrant birds remain in numbers far south of the breeding grounds until early June: Jamaica, June 12, 1863 (Field); Arcos Keys, Yucatan, June 6, 1900 (Nelson and Goldman); Key West, Fla., June 14, 1888 (Scott); Long Island, New York, average June 4, latest June 9, 1905 (Latham); Toronto, Ontario, June 17, 1894 (Fleming).

Fall migration.—The southward movement must begin in July, for by early August migrants have appeared over much of the coasts of the United States. Some dates of fall arrival are: Monomoy Island, Massachusetts, July 27, 1886 (Cahoon); Long Island, New York, average August 5, earliest July 27, 1892 (Scott); Monterey, Calif., July 18, 1892 (Loomis); Fort Churchill, Keewatin, July 30, 1900 (Preble); common at Corpus Christi, Tex., after July 1, 1887 (Sennett); Toronto, Ontario, July 30, 1898 (Nash); Henley Harbor, Ungava, August 20, 1860 (Coues); Mingan Island, Gulf of St. Lawrence, August 16, 1887 (Palmer); Montreal, Canada, August 17, 1891 (Wintle); Erie, Pa., August 24, 1889 (Sennett); Punta Rassa, Fla., August 2, 1886 (Scott); San Mateo, Tehuantepec, August 9, 1869 (Sumichrast); Jamaica, August 13, 1863 (March); Bermudas, August 3, 1874 (Reid); Talcahuano, Chile, September 9, 1879 (Sharpe). Dates of the last seen are: York Factory, August 26, 1900 (Preble); eastern Massachusetts, October 9, 1889 (Miller); Erie, Pa., September 25, 1900 (Todd); Long Island, New York, September 20, 1889 (Scott), accidental November 24, 1887 (Scott).

Black Turnstone. *Arenaria melanocephala* (Vig.).

Breeding range.—The black turnstone breeds commonly on the coast of Alaska near the mouth of the Yukon (Nelson) and up the Yukon as far as Nulato (Dall and Bannister). It breeds less commonly north to Kotzebue Sound (Townsend) and south to Nushagak (McKay). It has been seen on the eastern side of Bering Strait nearly to Point Barrow, Alaska (Nelson), and on the western side to Herald Island (Nelson), off the northern coast of Siberia, but it is not yet known to breed in either of these localities.

Winter range.—The greater number winter on the coast of Lower California, south to Magdalena Bay (Anthony). The species is not rare in winter on the California coast as far north as San Francisco (Mailliard), and a few have been known to winter at the Strait of Juan de Fuca (Suckley). It may winter occasionally even in southeastern Alaska, for the National Museum has a specimen collected February 2, 1897, at Howkan Island, Alaska (Cantwell).

Spring migration.—The species arrived at St. Michael, Alaska, about the middle of May (Nelson) and at Nulato, Alaska, May 16, 1867, and May 23, 1868 (Dall and Bannister).

Fall migration.—The black turnstone occurs on the Pacific coast from British Columbia (Kermode) to southern California throughout the entire summer, but is not known to breed (Grinnell). The presence of these nonbreeding birds prevents accurate observations on the arrival of the first migrants from the north, but it seems probable that early in July some appear on the coast of central California, and the species was seen August 6, 1902, on the Coronados Islands, Lower California (Grinnell and Daggett). The last leave the delta of the Yukon about the middle of September (Nelson) and Nushagak, Alaska, September 22, 1902 (Osgood).

European Oyster-catcher. *Hæmatopus ostralegus* Linn.

The southwestern coast of Greenland has been visited several times by the European oyster-catcher, once as far north as Godthaab, latitude 64° (Winge). It is not certainly known to breed there, but its breeding range extends from Iceland and western Europe to Turkestan and from southern Europe to the Arctic coast. It winters from central Europe to central Africa and to western India.

Oyster-catcher. *Hæmatopus palliatus* Temm.

The oyster-catcher ranges south to Santa Catharina, southern Brazil (Sharpe), and to Arauco in central Chile (Sharpe). It occurs throughout most of the West Indies and Central America and along both coasts of Mexico—on the west coast north to the Tres Marias (Nelson). On the Atlantic coast it is resident as far north as South Carolina (Coues), and formerly was common on the Virginia coast (Bailey), and bred at Great Egg Harbor, New Jersey (Wilson). There are a few records for the coast of Massachusetts (Brewer) and one at Grand Manan, New Brunswick (Boardman). At the present time it is rare or accidental north of Virginia, though a flock of about 20 was seen July 20, 1907, at Digby, Nova Scotia, by W. H. Osgood, of the Biological Survey. It is still resident on the coasts of Louisiana and Texas.

It breeds throughout most of its regular range and probably most individuals are nonmigratory. The few that migrate along the southern Atlantic coast perform their short migrations principally in March. Eggs were taken at Corpus Christi, Tex., in 1882, April 6 to 27 (Goss). Eggs are recorded in Florida from April 10 to May 6; and they have been collected on the islands of the Virginia coast from May 3 to July 12.

Frazar Oyster-catcher. *Hæmatopus frazari* Brewst.

The Frazar oyster-catcher is apparently nonmigratory, and is the common breeding bird of both coasts of southern Lower California, whence it ranges along the whole west coast of the peninsula and north to San Diego (Cooper), the coast of Ventura County (Evermann), and the Santa Barbara Islands (Cooper), casual on the coast of Sinaloa, Mexico (Nelson and Goldman). In the northern part of its range it is not so numerous as *bachmani*, whose range overlaps that of *frazari* for about a thousand miles from Ventura County, Calif., to Abreojos Point, Lower California (Kaeding).

Black Oyster-catcher. *Hæmatopus bachmani* Aud.

The coast of western North America is the home of the black oyster-catcher, and it breeds locally throughout its range from Abreojos Point, Lower California (Kaeding), north to Prince William Sound, Alaska (Grinnell), and west to Attu Island (Turner) at the western end of the Aleutian chain. It winters from the coast of southern British Columbia (Fannin) southward. The short migration is performed during May, and the eggs are deposited at the northern end of the range from the middle to the latter part of June. This is also the time at which eggs are most commonly found at the extreme southern end of the summer home. Downy young were taken June 17, 1900, on Queen Charlotte Islands, British Columbia (Osgood).

[**Stone Curlew.** *Œdicnemus bistriatus* (Wagler).

The stone curlew is somewhat generally distributed throughout the lower portions of Central America from Panama to southern Mexico, and also ranges into South America north of the Amazon. It is nonmigratory.]

Mexican Jacana. *Jacana spinosa* (Linn.).

The Mexican jacana was described originally from Cartagena, Colombia, and as that remains still the only record for the country, the ascription to this locality was probably an error. The species is known from Divala, Panama (Bangs), and thence north on the Pacific side to Mazatlan, Mexico (Lawrence), and on the Gulf side to the mouth of the Rio Grande (Merrill). It is recorded from Porto Rico (Gundlach), Haiti (Ritter), Jamaica (Denny), and Cuba (Vigors)—rare in the first three and common in Cuba. One was taken October, 1899, at Lake Okeechobee, Florida (Mearns)—first record for the State. The species is resident throughout its regular range and breeds for about half the year from March to September.

[**Black Jacana.** *Parra nigra* (Gmel.).

The black jacana is a nonmigratory species inhabiting northern South America and occurring in southern Panama.]

[**Colombian Jacana.** *Parra melanopygia* (Sclater).

A nonmigratory South American species found principally in Colombia, but extending north to Panama.]

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U. S. DEPARTMENT OF AGRICULTURE

BIOLOGICAL SURVEY—BULLETIN No. 35, Revised

HENRY W. HENSHAW, *Chief*

DISTRIBUTION AND MIGRATION OF NORTH AMERICAN SHOREBIRDS

BY

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WASHINGTON
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey,
Washington, D. C., March 9, 1912.

Sir: I have the honor to transmit herewith, for publication, a revision of Bulletin No. 35 of the Biological Survey, on the Distribution and Migration of North American Shorebirds, by Wells W. Cooke, assistant, Biological Survey. The original edition was issued October 6, 1910.

Many species of shorebirds inhabit the United States or pass through our territory in migration. These birds possess considerable economic importance, and as other wild game like ducks, geese, and swans diminish in numbers their value for food and as a means for sport will increase. Large numbers are annually killed, and unless prompt measures are taken adequately to protect them some of the larger and more important kinds are likely to become extinct, especially in the region east of the Mississippi River. A knowledge of the summer and winter abodes of the several species and of the routes they take in migration is essential to intelligent legislation in their behalf, and, accordingly, all the known facts in regard to this part of their life history are here brought together.

Respectfully,

Henry W. Henshaw,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.

Introduction 5
Distribution 6
Migration 10
North American shorebirds 14
  Red phalarope 14
  Northern phalarope 16
  Wilson phalarope 18
  Avocet 19
  Black-necked stilt 20
  European woodcock 21
  Woodcock 21
  European snipe 23
  Wilson snipe 23
  Great snipe 26
  Dowitcher 26
  Long-billed dowitcher 28
  Stilt sandpiper 29
  Knot 31
  Purple sandpiper 33
  Aleutian sandpiper 34
  Pribilof sandpiper 34
  Sharp-tailed sandpiper 34
  Pectoral sandpiper 35
  White-rumped sandpiper 37
  Baird sandpiper 39
  Least sandpiper 41
  Long-toed stint 42
  Cooper sandpiper 43
  Dunlin 43
  Red-backed sandpiper 43
  Curlew sandpiper 45
  Spoon-bill sandpiper 45
  Semipalmated sandpiper 46
  Western sandpiper 47
  Sanderling 48
  Marbled godwit 50
  Pacific godwit 51
  Hudsonian godwit 52
  Black-tailed godwit 53
  Green-shank 54
  Common red-shank 54
  Greater yellow-legs 54
  Yellow-legs 56
  Solitary sandpiper 58
  Western solitary sandpiper 60
  Green sandpiper 61
  Wood sandpiper 61
  Willet 61

North American shorebirds—Continued.

Page.
Western willet.......... 62
Wandering tattler.......... 63
Ruff.......... 64
Upland plover.......... 64
Buff-breasted sandpiper.......... 67
Spotted sandpiper.......... 69
Long-billed curlew.......... 71
Hudsonian curlew.......... 72
Eskimo curlew.......... 74
European curlew.......... 76
Whimbrel.......... 77
Bristle-thighed curlew.......... 77
Lapwing.......... 77
Dotterel.......... 77
Black-bellied plover.......... 78
European golden plover.......... 79
Golden plover.......... 80
Pacific golden plover.......... 85
Killdeer.......... 85
Santo Domingo killdeer.......... 88
Semipalmated plover.......... 88
Ringed plover.......... 90
Little ringed plover.......... 90
Piping plover.......... 91
Snowy plover.......... 92
Mongolian plover.......... 93
Azara ring plover.......... 93
Wilson plover.......... 93
Rufous-naped plover.......... 94
Mountain plover.......... 94
Surf bird.......... 95
Turnstone.......... 96
Ruddy turnstone.......... 97
Black turnstone.......... 98
European oyster-catcher.......... 99
Oyster-catcher.......... 99
Frazar oyster-catcher.......... 99
Black oyster-catcher.......... 100
Stone curlew.......... 100
Mexican jacana.......... 100
Black jacana.......... 100
Colombian jacana.......... 100

LIST OF ILLUSTRATIONS.

Page.
PLATE I. Yellow-legs (*Totanus flavipes*).......... 56
II. Upland plover (*Bartramia longicauda*).......... 64
III. Spotted sandpiper (*Actitis macularia*).......... 68
IV. Killdeer (*Oxyechus vociferus*).......... 84

DISTRIBUTION AND MIGRATION OF NORTH AMERICAN SHOREBIRDS.

INTRODUCTION.

Shorebirds form a valuable national resource, and it is the plain duty of the present generation to pass on to posterity this asset undiminished in value. Consistent and intelligent legislation in favor of any group of birds must be founded on extended, accurate information, and must include knowledge of the breeding and distribution of the birds—where they spend the summer, whither they retire in winter, and when and by what routes they migrate. The present bulletin supplies this needed information so far as it is now available.

Consideration of our shorebirds (*Limicolæ*) from an economic point of view is recent. The early settlers found ducks, geese, and swans swarming in certain sections of the United States, and grouse and turkeys very abundant. The size and toothsomeness of these birds made them important objects of pursuit for food, while the shorebirds were considered unworthy of notice. As the great flocks of ducks and geese along the Atlantic coast diminished in numbers, the attention of gunners, especially of market hunters, was turned to the shorebirds, then in countless numbers. A generation of constant harassment spring and fall has almost exterminated some of the larger species and has very greatly reduced even the smaller ones. The time has come when this indiscriminate slaughter must cease if the present remnant of the shorebirds is to be preserved.

The range of our shorebirds extends from ocean to ocean, so that all parts of the United States have an interest in their preservation. These birds feed naturally in the open country or along the open shore, where they are easily found and are constantly subject to attack. The prairies of the Mississippi Valley in past years formed the great highway of spring migration. Flock followed flock in almost endless succession across the prairies of Kansas, Nebraska, and the Dakotas, over a region that of late years has passed under the plow. As this area becomes more densely populated the shorebirds, once so abundant, are likely to become extinct unless active measures are taken for their preservation.

There are excellent reasons for protecting and preserving the shorebirds. Some of them, especially the several kinds of plovers, perform important service in destroying noxious insects. The flesh of many of them, even of the smaller kinds, has a high food value, and some of the larger species—the upland, golden, and black-bellied plovers, and the curlews—were in the times of their abundance important articles of diet. Their pursuit for sport, when they are shot over decoys, demands a high degree of skill, and is a favorite pastime of many hunters. Nor should the esthetic side of the question be ignored. The graceful forms and motions of these birds as they feed at the edge of the breakers are an interesting sight to thousands of seashore visitors. The silencing of their melodious calls would be a loss to every lover of nature. Finally, it may be said in their favor that not one of the shorebirds ever does any harm, while many have proved of great value to agriculture. Their accounts have only a credit side.

The shorebirds are among the most widely distributed of all birds. As far to the northward as man has found land shorebirds breed, while in winter they visit the tropical and Antarctic shores. The distances traversed in their migrations probably average greater than those of any other family, and the shorebirds probably exceed all others in the number of miles traveled in a single flight.

DISTRIBUTION.

The shorebirds are represented in North America by 76 species and 9 subspecies, a total of 85 recognized forms; but the following 7 of these do not range so far north as the United States:

SOUTHERN SPECIES NOT RANGING NORTH TO THE UNITED STATES.

Rufous-naped plover (*Ochthodromus wilsonius rufinuchus*).
Stone curlew (*Œdicnemus bistriatus*).
Colombian jacana (*Parra melanopygia*).
Black jacana (*Parra nigra*).
Cayenne lapwing (*Hoploxypterus cayanus*).
Azara ring plover (*Ægialitis collaris*).
Santo Domingo killdeer (*Oxyechus vociferus torquatus*).

There remain 78 species and subspecies that occur in the United States and northward, but 5 of these are found only in Greenland, as follows:

EUROPEAN SPECIES OCCURRING IN NORTH AMERICA ONLY IN GREENLAND.

European snipe (*Gallinago gallinago*).
Black-tailed godwit (*Limosa limosa*).
Whimbrel (*Numenius phæopus*).
Golden plover (*Charadrius apricarius*).
Oyster-catcher (*Hæmatopus ostralegus*).

Fifteen other species from the Eastern Hemisphere are known as stragglers on the mainland of North America:

STRAGGLERS IN NORTH AMERICA FROM THE EASTERN HEMISPHERE.

European woodcock (*Scolopax rusticola*).
Great snipe (*Gallinago media*).
Long-toed stint (*Pisobia damacensis*).
Dunlin (*Pelidna alpina*).
Curlew sandpiper (*Erolia ferruginea*).
Spoon-bill sandpiper (*Eurynorhynchus pygmeus*).
Green-shank (*Glottis nebularia*).
Red-shank (*Totanus totanus*).
Green sandpiper (*Helodromas ocrophus*).
Wood sandpiper (*Rhyacophilus glareola*).
Ruff (*Pavoncella pugnax*).
Lapwing (*Vanellus vanellus*).
Dotterel (*Eudromias morinellus*).
Little ringed plover (*Ægialitis dubia*).
Mongolian plover (*Ægialitis mongola*).

Deducting these, there are 58 species of shorebirds that belong to the regular avifauna of North America north of Mexico. Not all of these, however, occur in the United States. The sharp-tailed sandpiper is a regular migrant through Alaska, but is not found elsewhere in North America. The Pacific godwit, bristle-thighed curlew, and Pacific golden plover breed in Alaska and migrate thence to Asia and the Pacific islands. The ringed plover breeds in northeastern North America and migrates to Europe. The turnstone breeds in both northeastern and northwestern Arctic America, but migrates to Europe, Asia, and the Pacific islands without coming regularly to the United States; while the Aleutian and the Pribilof sandpipers both breed and winter in Alaska. A further deduction of these 8 species leaves 50 species which regularly visit the United States during some part of the year.

The shorebirds as a group are far northern breeders. The majority of them breed in the region of the Arctic Circle, and several range north to the known limits of land. The majority do not breed so far south as the United States, and hence are known there only as migrants, or in the winter season.

Species that Breed Wholly North of the United States.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Dowitcher (*Macrorhamphus griseus*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Stilt sandpiper (*Micropalama himantopus*).
Knot (*Tringa canutus*).
Purple sandpiper (*Arquatella maritima*).
Aleutian sandpiper (*Arquatella maritima couesi*).
Pribilof sandpiper (*Arquatella maritima ptilocnemis*).
Sharp-tailed sandpiper (*Pisobia aurita*).
Pectoral sandpiper (*Pisobia maculata*).
White-rumped sandpiper (*Pisobia fuscicollis*).
Baird sandpiper (*Pisobia bairdi*).
Least sandpiper (*Pisobia minutilla*).
Red-backed sandpiper (*Pelidna alpina sakhalina*).
Semipalmated sandpiper (*Ereunetes pusillus*).
Western sandpiper (*Ereunetes mauri*).
Sanderling (*Calidris leucophæa*).
Pacific godwit (*Limosa lapponica baueri*).
Hudsonian godwit (*Limosa hæmastica*).
Greater yellow-legs (*Totanus melanoleucus*).
Yellow-legs (*Totanus flavipes*).
Wandering tattler (*Heteractitis incanus*).
Buff-breasted sandpiper (*Tryngites subruficollis*).
Hudsonian curlew (*Numenius hudsonicus*).
Eskimo curlew (*Numenius borealis*).
Bristle-thighed curlew (*Numenius tahitiensis*).
Black-bellied plover (*Squatarola squatarola*).
Golden plover (*Charadrius dominicus*).
Pacific golden plover (*Charadrius dominicus fulvus*).
Semipalmated plover (*Ægialitis semipalmata*).
Ringed plover (*Ægialitis hiaticula*).
Surf bird (*Aphriza virgata*).
Turnstone (*Arenaria interpres*).
Ruddy turnstone (*Arenaria interpres morinella*).
Black turnstone (*Arenaria melanocephala*).

Species that Breed in Both the United States and Canada.

Wilson phalarope (*Steganopus tricolor*).
Avocet (*Recurvirostra americana*).
Woodcock (*Philohela minor*).
Wilson snipe (*Gallinago delicata*).
Marbled godwit (*Limosa fedoa*).
Solitary sandpiper (*Helodromas solitarius*).
Western solitary sandpiper (*Helodromas salitarius cinnamomeus*).
Willet (*Catoptrophorus semipalmatus*).
Western willet (*Catoptrophorus semipalmatus inornatus*).
Upland plover (*Bartramia longicauda*).
Spotted sandpiper (*Actitis macularia*).
Long-billed curlew (*Numenius americanus*).
Killdeer (*Oxyechus vociferus*).
Piping plover (*Ægialitis meloda*).
Black oyster-catcher (*Hæmatopus bachmani*).

Species that do not Breed North of the United States, with Northern Limit of Breeding Range.

Black-necked stilt (*Himantopus mexicanus*), Oregon.
Snowy plover (*Ægialitis nivosa*), Nevada.
Wilson plover (*Ochthodromus wilsonius*), Virginia.
Mountain plover (*Podasocys montanus*), Montana.
Oyster-catcher (*Hæmatopus palliatus*), South Carolina.
Frazar oyster-catcher (*Hæmatopus frazari*), California.
Mexican jacana (*Jacana spinosa*), Texas.

Species that Breed Chiefly North of the Arctic Circle, with the Northernmost Latitude at Which the Species has been Observed in the Western Hemisphere.

Red phalarope (*Phalaropus fulicarius*), 82°.
Northern phalarope (*Lobipes lobatus*), 74°.
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*), 71°.
Stilt sandpiper (*Micropalama himantopus*), 69°.
Knot (*Tringa canutus*), 83°.
Purple sandpiper (*Arquatella maritima*), 74°.
Pectoral sandpiper (*Pisobia maculata*), 71°.
White-rumped sandpiper (*Pisobia fuscicollis*), 69°.
Baird sandpiper (*Pisobia bairdi*), 71°.
Least sandpiper (*Pisobia minutilla*), 70°.
Red-backed sandpiper (*Pelidna alpina sakhalina*), 72°.
Semipalmated sandpiper (*Ereunetes pusillus*), 71°.
Sanderling (*Calidris leucophæa*), 82°.
Hudsonian godwit (*Limosa hæmastica*), 69°.
Buff-breasted sandpiper (*Tryngites subruficollis*), 71°.
Hudsonian curlew (*Numenius hudsonicus*), 69°.
Eskimo curlew (*Numenius borealis*), 69°.
Black-bellied plover (*Squatarola squatarola*), 71°.
Golden plover (*Charadrius dominicus*), 77°.
Pacific golden plover (*Charadrius dominicus fulvus*), 65°.
Semipalmated plover (*Ægialitis semipalmata*), 75°.
Ringed plover (*Ægialitis hiaticula*), 78°.
Turnstone (*Arenaria interpres*), 83°.
Ruddy turnstone (*Arenaria interpres morinella*), 74°.

Species that Breed in Both Eastern and Western Hemispheres.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Knot (*Tringa canutus*).
Purple sandpiper (*Arquatella maritima*).
Sanderling (*Calidris leucophæa*).
Pacific godwit (*Limosa lapponica baueri*).
Black-bellied plover (*Squatarola squatarola*).
Pacific golden plover (*Charadrius dominicus fulvus*).
Ringed plover (*Ægialitis hiaticula*).
Turnstone (*Arenaria interpres*).

Species that Winter in the United States and Southward.

Avocet (*Recurvirostra americana*).
Black-necked stilt (*Himantopus mexicanus*).
Woodcock (*Philohela minor*).
Wilson snipe (*Gallinago delicata*).
Dowitcher (*Macrorhamphus griseus*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Purple sandpiper (*Arquatella maritima*).
Least sandpiper (*Pisobia minutilla*).
Red-backed sandpiper (*Pelidna alpina sakhalina*).
Semipalmated sandpiper (*Ereunetes pusillus*.)
Western sandpiper (*Ereunetes mauri*).
Sanderling (*Calidris leucophæa*).
Marbled godwit (*Limosa fedoa*).
Greater yellow-legs (*Totanus melanoleucus*.)
Yellow-legs (*Totanus flavipes*).
Western willet (*Catoptrophorus semipalmatus inornatus*).
Spotted sandpiper (*Actitis macularia*).
Long-billed curlew (*Numenius americanus*).
Black-bellied plover (*Squatarola squatarola*).
Killdeer (*Oxyechus vociferus*).
Semipalmated plover (*Ægialitis semipalmata*).
Piping plover (*Ægialitis meloda*).
Snowy plover (*Ægialitis nivosa*).
Wilson plover (*Ochthodromus wilsonius*).
Mountain plover (*Podasocys montanus*).
Ruddy turnstone (*Arenaria interpres morinella*).
Black turnstone (*Arenaria melanocephala*).
Oyster-catcher (*Hæmatopus palliatus*).
Frazar oyster-catcher (*Hæmatopus frazari*).
Black oyster-catcher (*Hæmatopus bachmani*).
Mexican jacana (*Jacana spinosa*).

Species that do not Winter North of South America.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Wilson phalarope (*Steganopus tricolor*).
Stilt sandpiper (*Micropalama himantopus*).
Knot (*Tringa canutus*).
Pectoral sandpiper (*Pisobia maculata*).
White-rumped sandpiper (*Pisobia fuscicollis*).
Baird sandpiper (*Pisobia bairdi*).
Hudsonian godwit (*Limosa hæmastica*).
Solitary sandpiper (*Helodromas solitarius*).
Western solitary sandpiper (*Helodromas solitarius cinnamomeus*).
Upland plover (*Bartramia longicauda*).
Buff-breasted sandpiper (*Tryngites subruficollis*).
Eskimo curlew (*Numenius borealis*).
Golden plover (*Charadrius dominicus*).
Surf bird (*Aphriza virgata*).

The three following species winter in the West Indies or Central America and southward, but are not found at this season in the United States: Willet (*Catoptrophorus semipalmatus*), wandering tattler (*Heteractitis incanus*), and Hudsonian curlew (*Numenius hudsonicus*). The purple sandpiper (*Arquatella maritima*) remains in winter as far north as Greenland and does not range south of the United States; while the Aleutian sandpiper (*Arquatella maritima couesi*) and the Pribilof sandpiper (*Arquatella maritima ptilocnemis*) do not occur in winter south of Alaska.

Species that Range South in Winter to South America, with the Southern Limit of the Winter Range.

Red phalarope (*Phalaropus fulicarius*), Falkland Islands.
Northern phalarope (*Lobipes lobatus*), Peru and probably farther.
Wilson phalarope (*Steganopus tricolor*), Falkland Islands.
Black-necked stilt (*Himantopus mexicanus*), Peru.
Dowitcher (*Macrorhamphus griseus*), Brazil.
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*), probably Peru.
Stilt sandpiper (*Micropalama himantopus*), Uruguay.
Knot (*Tringa canutus*), Tierra del Fuego.
Pectoral sandpiper (*Pisobia maculata*), Argentina.
White-rumped sandpiper (*Pisobia fuscicollis*), Tierra del Fuego.
Baird sandpiper (*Pisobia bairdi*), Chile.
Least sandpiper (*Pisobia minutilla*), Chile.
Semipalmated sandpiper (*Ereunetes pusillus*), Patagonia.
Western sandpiper (*Ereunetes mauri*), Venezuela.
Sanderling (*Calidris leucophæa*), Argentina.
Hudsonian godwit (*Limosa hæmastica*), Strait of Magellan.
Greater yellow-legs (*Totanus melanoleucus*), Strait of Magellan.
Yellow-legs (*Totanus flavipes*), Strait of Magellan.
Solitary sandpiper (*Helodromas solitarius*), Argentina.
Western solitary sandpiper (*Helodromas solitarius cinnamomeus*), not known.
Willet (*Catoptrophorus semipalmatus*), Peru.
Upland plover (*Bartramia longicauda*), Argentina.
Buff-breasted sandpiper (*Tryngites subruficollis*), Argentina.
Spotted sandpiper (*Actitis macularia*), Peru.
Hudsonian curlew (*Numenius hudsonicus*), Chile.
Eskimo curlew (*Numenius borealis*), Patagonia.
Black-bellied plover (*Squatarola squatarola*), Peru.
Golden plover (*Charadrius dominicus*), Argentina.
Semipalmated plover (*Ægialitis semipalmata*), Argentina.
Snowy plover (*Ægialitis nivosa*), Chile.
Surf bird (*Aphriza virgata*), Chile.
Ruddy turnstone (*Arenaria interpres morinella*), Chile.
Oyster-catcher (*Hæmatopus palliatus*), Chile.

SPECIES THAT OCCUR IN THE UNITED STATES ONLY AS MIGRANTS, BREEDING IN THE FAR NORTH AND WINTERING TO THE SOUTHWARD.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Stilt sandpiper (*Micropalama himantopus*).
Knot (*Tringa canutus*).
Pectoral sandpiper (*Pisobia maculata*).
White-rumped sandpiper (*Pisobia fuscicollis*).
Baird sandpiper (*Pisobia bairdi*).
Hudsonian godwit (*Limosa hæmastica*).
Buff-breasted sandpiper (*Tryngites subruficollis*).
Hudsonian curlew (*Numenius hudsonicus*).
Eskimo curlew (*Numenius borealis*).
Golden plover (*Charadrius dominicus*).
Surf bird (*Aphriza virgata*).

SUMMARY.

Species that do not breed north of the United States	7
Species breeding in the United States and Canada	15
Total species breeding in the United States	22
Species breeding wholly north of the United States	36
Species breeding north of and wintering in the United States	15
Species breeding or wintering in the United States	37
Species occuring in the United States as migrants only	13
Total species occurring in the United States	50
Species occurring regularly in Arctic America, but not in the United States	8
Total species occurring regularly in North America north of Mexico	58
European species straggling to Greenland	5
Eastern Hemisphere species straggling to North America	15
Southern species not ranging north to the United States	7
Total species and subspecies in North America	85

MIGRATION.

The shorebirds as a group are among the most wide ranging of migrants. While a few, for example the jacanas, do not migrate at all, most shorebirds migrate more than a thousand miles each season, and many lengthen their journeys to 7,000 miles. The most wonderful feature of their migration is the enormous distance covered in a single flight. As explained in the account of the golden plover, many flocks of plover fly without resting from Nova Scotia to northern South America, a distance of about 2,500 miles. Many individuals of other species perform the same flight, notably the Eskimo curlew, while in the case of the Hudsonian godwit and the upland plover the principal place of departure in fall migration is the coast of the United States north of Virginia, and many of the flocks make stops in the Lesser Antilles on their way to South America.

That the same route is employed by other species is shown by the large number of shorebirds annually visiting the Bermudas. These islands lie about 800 miles off the coast of South Carolina and are in a nearly direct line from southern Nova Scotia to the Lesser Antilles. Years ago, when shorebirds were far more numerous than now, many flocks stopped at the Bermudas in fall migration. The most common species were the pectoral, white-rumped, least, and semipalmated sandpipers, the sanderling, greater yellow-legs, lesser yellow-legs, solitary sandpiper, spotted sandpiper, Hudsonian curlew, semipalmated plover, turnstone, and Wilson snipe. All of these came in sufficient numbers to show that their visits were not accidental, and evidently they had merely paused a few days on their journey to the Lesser Antilles. The killdeer appeared regularly in November and remained through the winter, but since this species scarcely goes north of New England, the individuals wintering on the Bermudas must have visited the islands for the purpose of remaining there through the cold season. Specimens of eleven other species of shorebirds have been taken in the Bermudas. They are less common visitors, and most of these individuals were probably on their way across the ocean to the Lesser Antilles.

This route, however, is not followed by these species in their return in the spring, and there seems to be no evidence as yet that any species of shorebird migrates regularly in the spring across the ocean from the Lesser Antilles to the coast of New England or to eastern Canada. Indeed, shorebirds migrating north in spring through the Lesser Antilles are almost unknown.

Along the Atlantic coast shorebirds are many times more numerous in fall than in spring, while in the Mississippi Valley there is no such pronounced difference of numbers at the two seasons. This fact, taken in connection with the rarity of all species of shorebirds during the spring migration in the West Indies, where they are abundant fall visitors, seems to indicate that in the case of most of the species of shorebirds that migrate south in fall along the Atlantic coast some individuals pass northward in spring by way of the Mississippi Valley. The Eskimo curlew used to follow this route, as still do most of the golden plover. The statement applies also largely to the long-billed dowitcher, stilt, white-rumped, and semipalmated sandpipers, and the lesser yellow-legs. This elliptical migration route is in the case of most species not less than 6,000 miles in its north and south diameter, nor less than 2,000 miles east and west, while the winter home of the white-rumped sandpiper is 9,000 miles from its breeding grounds.

The Hawaiian Islands lie in the Pacific Ocean 2,000 miles from the nearest mainland to the eastward and more than 3,000 miles from the Asiatic coast. The nearest point of Alaska is about 2,000 miles north. Five species of shorebirds that summer in Alaska are found in the Hawaiian Islands during the winter season. They are the turnstone, Pacific golden plover, sanderling, bristle-thighed curlew, and wandering tattler. There is every reason to believe that these Hawaiian birds come from Alaska and that they make the 2,000-mile trip at a single flight. All of these species occur farther south in Oceania, but there seems to be no evidence that any of them use the Hawaiian Islands as a stopping place on the way to a more southern home. Apparently all the birds that fly to the Hawaiian Islands remain there through the winter, while the southern islands of Oceania are populated by individuals that have migrated along the Asiatic coast. It is remarkable that in the case of both the turnstone and the plover the first individuals to arrive on the Hawaiian Islands in the fall are in good condition or even fat, while the curlew and plover that reach the Lesser Antilles by a long flight over the Atlantic Ocean are reported as emaciated.

Shorebirds present some idiosyncrasies of migration that are worthy of mention. The sharp-tailed sandpiper (*Pisobia aurita*) breeds on the northern coast of Siberia, and in fall migration crosses to Alaska and then back again to Asia and by way of Japan and China reaches its winter home in Australia. The most eastern point of its range in Alaska—Norton Sound—is some 500 miles east of its summer home in Siberia. As the species is not known in Alaska in spring, its migration route is probably elliptical, and the northern route in spring is probably across the mainland of Asia.

Some individuals of the marbled godwit (*Limosa fedoa*) have a unique migration route. From their breeding grounds in North Dakota and Saskatchewan some of these birds formerly migrated almost directly east more than a thousand miles to the Atlantic coast, while others traveled a thousand miles due west to the coast of southern Alaska.

Some birds breed in the Western Hemisphere and winter in the Eastern. For example, the Pacific godwit (*Limosa lapponica baueri*) breeds on the western shores of Alaska, whence it passes by way of the Commander Islands, Japan, and China to its winter home in Australia. The bristle-thighed curlew (*Numenius tahitiensis*) follows a somewhat similar route. The wandering tattler (*Heteractitis incanus*) breeds in Alaska and some individuals pass in fall migration to Asia, Hawaii, and Oceania, while others continue down the American coast to the Galapagos.

A long migration route from the eastern side of North America is followed by the ringed plover (*Ægialitis hiaticula*). Some individuals breed in Greenland and still farther west in Ellesmere Land and about Cumberland Sound, whence they pass east and southeast to the European coast and winter from the Mediterranean to southern Africa.

Both these last routes are used by the turnstone (*Arenaria interpres*). The individuals that breed in Greenland and Ellesmere Land migrate southeast to Europe and Africa, while those that breed in Alaska, even as far east as Point Barrow, migrate to the west and southwest to winter in Asia and Oceania.

Another migration route, probably unique, is that taken by the considerable numbers of the mountain plover (*Podasocys montanus*) that winter in the Sacramento Valley and elsewhere in California. The farthest west and north that the species is known to breed is Montana; hence whether the California wintering birds come from Montana or from the more southern districts, they apparently form an exception to the general rule that North American birds do not winter farther west than they breed.

Though many of the shorebirds breeding in North America winter in the southern part of South America, none of them breed in their winter home. Special attention needs to be called to this fact, because nearly a dozen species of this family—among which may be noted particularly the greater and lesser yellow-legs and the white-rumped sandpiper—have been reported as breeding near the southern end of South America. In no case has it been claimed that the eggs have been found, and all the records are based on the finding of young not fully grown or in most cases simply from the presence of individuals during the usual breeding season of local species. This latter reason is not even presumptive of breeding. Nearly a hundred species of North American birds escape the winter of the Northern Hemisphere by visiting South America, and they remain there through what is the breeding season of the resident species, but do not themselves undertake any household cares. It may be stated positively that none of the Limicolæ that breed north of the equator breed also in the southern part of their range.

Species that are Regular Migrants Spring and Fall on the Atlantic and the Pacific Coasts and in the Interior.

American avocet (*Recurvirostra americana*).
Wilson snipe (*Gallinago delicata*).
Least sandpiper (*Pisobia minutilla*).
Greater yellow-legs (*Totanus melanoleucus*).
Spotted sandpiper (*Actitis macularia*).
Black-bellied plover (*Squatarola squatarola*).
Killdeer (*Oxyechus vociferus*).
Semipalmated plover (*Ægialitis semipalmata*).

Species that are Regular Migrants Spring and Fall on both the Atlantic and the Pacific Coasts, but are Rare or Wanting in the Interior.

Red phalarope (*Phalaropus fulicarius*).
Northern phalarope (*Lobipes lobatus*).
Red-backed sandpiper (*Pelidna alpina sakhalina*).
Sanderling (*Calidris leucophæa*).
Hudsonian curlew (*Numenius hudsonicus*).
Ruddy turnstone (*Arenaria interpres morinella*).

Species that are Regular Migrants Spring and Fall on the Atlantic Coast and in the Interior, but are Rare or Wanting on the Pacific Coast.

Woodcock (*Philohela minor*).
Knot (*Tringa canutus*).
Pectoral sandpiper (*Pisobia maculata*).
Solitary sandpiper (*Helodromas solitarius*).
Piping plover (*Ægialitis meloda*).

Species that are Regular Migrants Spring and Fall on the Pacific Coast and in the Interior, but are Rare or Wanting on the Atlantic Coast.

Wilson phalarope (*Steganopus tricolor*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Western willet (*Catoptrophorus semipalmatus inornatus*).
Long-billed curlew (*Numenius americanus*).

Species that Occur in Migration Principally on the Pacific Coast.

Black-necked stilt (*Himantopus mexicanus*).
Western sandpiper (*Ereunetes mauri*).
Western solitary sandpiper (*Helodromas solitarius cinnamomeus*).
Wandering tattler (*Heteractitis incanus*).
Snowy plover (*Ægialitis nivosa*).
Surf bird (*Aphriza virgata*).
Black turnstone (*Arenaria melanocephala*).
Black oyster-catcher (*Hæmatopus bachmani*).

Western Species that Come East in Migration to the Atlantic Coast.

Wilson phalarope (*Steganopus tricolor*).
Long-billed dowitcher (*Macrorhamphus griseus scolopaceus*).
Baird sandpiper (*Pisobia bairdi*).
Western sandpiper (*Ereunetes mauri*).

The data on the breeding and wintering of the shorebirds has been collated from all available printed sources, from the manuscript reports of the field naturalists of the Biological Survey, and from the specimens and catalogues of the United States National Museum. The dates of migration have been obtained principally from the migration schedules sent in by the several hundred observers in the United States and Canada, who for a quarter of a century have contributed to the Biological Survey spring and fall reports of their observations. It is a pleasure to testify to the earnest and conscientious efforts these observers have put forth for the solving of some of the phases of Nature's great migration problem and to return thanks to them for their painstaking labors.

NORTH AMERICAN SHOREBIRDS.

Red Phalarope. *Phalaropus fulicarius* (Linn.).

Breeding range.—The summer home of the red phalarope is circumpolar, and the species is known at this season from the whole northern coast and islands of America, Europe, and Asia, except a few regions, the most notable of which is the eastern coast of Greenland. It has been known to breed south to St. Michael, Alaska, 68° N. (Nelson); to Cape Eskimo, west coast of Hudson Bay, 61° N. (Preble); Hudson Strait, 62° N. (Turner); and to the south end of Greenland, 60° N. (Schalow). It has been noted north to 83° N., north of Spitzbergen (Sverdrup); 82° 30′ N. on Ellesmere Island (Feilden); Melville Island, 74° 30′ N. (Parry); and Point Barrow, 71° N. (Murdoch). It is especially abundant as a breeder along the coast and islands of Arctic America.

Winter range.—The Old World winter home of the species extends south to Morocco, India, China, and New Zealand. Knowledge of the winter range in the Western Hemisphere is very meager. The species has been noted in the extreme southern parts of South America on the Falkland Islands (Schalow), and Juan Fernandez (Sharpe); in November, when it may have been migrating, at Coquimbo, northern Chile (Salvin); on December 5 in Chile, locality not designated (Sharpe); specimens are recorded from Argentina and Colombia (Sharpe), without date or locality. The lack of records for this species is remarkable. There seem to be no records whatever for the West Indies nor for the whole of middle America, except the western coast of Lower California, where the species is ordinarily a rare spring and fall migrant, but occasionally is seen in large flocks (Kaeding). Stragglers have been noted at Mount Pleasant, S. C., December 4, 1900 (Wayne); on the coast of northern Lower California, February 21 (Belding); and occasionally in winter at San Diego, Calif. (McGregor).

Migration range.—Enormous flocks of the red phalarope have been noted on the Atlantic Ocean during both spring and fall migration. These flocks are common and regular around Newfoundland; become less common southward off the coast of Maine; and are rare off the coast of Massachusetts, except when driven inshore by storms. The red phalarope swims as lightly and easily as any duck, and during migration has been noted repeatedly gathering its food from the surface of the ocean. Indeed, it seems to have an aversion to land except during the breeding season. The migration route by which these flocks of red phalarope pass south after they leave Massachusetts is unknown. The species is known only as a rare straggler on the coast of the United States south of Long Island, and as already remarked is not recorded from the West Indies nor from the east coast of South America north of Argentina. On the Pacific coast the species is an abundant breeder in Alaska, and the flocks pass along the coast of California both spring and fall, after which they can no longer be traced. A few occur on the coast of Lower California, and the species is a rare straggler to the coast of Chile. The principal winter home of the thousands of birds reared each season in arctic America remains yet to be determined.

The red phalarope occurs as a rare straggler in the interior of the United States in migration, and has been recorded from Illinois, Indiana, Ohio, Michigan, Ontario, Wisconsin, Minnesota, Kansas, and Wyoming. The first and only record for Colorado is that of a single specimen taken by Edward A. Preble, of the Biological Survey, July 25, 1895, near Loveland.

Spring migration.—Some early flocks appeared off the coast of North Carolina the first week in April, 1896 (Thayer); most of the migration on the coast of Massachusetts occurs during May, especially May 20–30; the first appeared June 2, 1820, on Melville Island, latitude 74° N. (Parry), and June 3, 1852 (Armstrong), near the same locality; on June 18, 1883, the first was seen at Fort Conger, Ellesmere Island, latitude 81° 40′ N. (Greely); and on June 20, 1876, the species appeared 1 degree farther north on the same island (Feilden). Even considering the 1st of May as the time of arrival on the Massachusetts coast, which is probably too early, there are left only fifty days for the 3,000-mile trip from Massachusetts to Ellesmere Island, an average rate of migration of 60 miles per day, which is exceeded by very few species. In spring migration the red phalarope has been noted on the coast of California from April 3 to June 3 (Kaeding), and reached Point Barrow, Alaska, June 4, 1882, and May 30, 1883 (Murdoch).

Eggs have been taken in Greenland June 3–28 (Hagerup); near Fort Anderson June 27 (MacFarlane); and at St. Michael June 8 (Nelson).

Fall migration.—The earliest fall birds are seen on the coast of California during July (Loomis); the larger flocks begin to appear late in August and pass south for the next three months. The last seen at Point Barrow, in 1882, was on October 10 (Murdoch). The species was abundant off the coast of Massachusetts August 4, 1877 (Kumlien); and has been noted on Long Island to the third week of November (Braislin).

Northern Phalarope. *Lobipes lobatus* (Linn.).

Breeding range.—The northern phalarope breeds in the arctic region of both hemispheres, but does not go quite so far north as the last species. It ranges from the Chuckchi Peninsula of Siberia eastward across the whole arctic coast of America to the eastern coast of Greenland. It breeds north to Upernivik, Greenland, 73° N. (Kumlien); Melville Island, 74° N. (Walker); Point Barrow, Alaska, 71° N. (Murdoch); and Wrangel Island, Siberia, 72° N. (Nelson). The main breeding ground lies farther south on the mainland of North America, especially in northern Mackenzie and western Alaska. It breeds south to Ungava Bay, about 59° N. (Turner); near Rupert House, Ontario (Drexler); to near York Factory, Keewatin, 57° N. (Preble); Fort Anderson, Mackenzie, 68° 35′ N. (MacFarlane); Pastolik, in the delta of the Yukon, Alaska, 63° N. (Dall and Bannister); and to Kiska Island, near the west end of the Aleutians, 52° N. (Dall). In the Eastern Hemisphere it is an abundant breeder from the limit of tree growth to the Arctic coast, and in eastern Siberia occasionally south to latitude 55°.

Winter range.—The winter home of the great flocks of northern phalaropes that breed in arctic America is unknown. The European and Siberian birds winter on the coast of Europe and south to Persia, India, China, and the Malay Archipelago. For the whole of the Atlantic coast of both North and South America there is not a single winter record. A solitary bird was noted at Tumbez, Peru, January 28 (Taczanowski); the species has been recorded from Chorillos, Peru, without date (Berlepsch and Stolzmann); and there is a specimen known from Patagonia (Dabbene). This lack of winter land records suggests the possibility that both this species and the red phalarope spend the winter in midocean feeding and sleeping on the surface of the water.

Migration range.—The northern phalarope comes south along the eastern coast of North America, and is seen commonly as far south as Nova Scotia. The flocks seem normally to strike south from Nova Scotia into midocean, but occasionally they are driven westward by storms and appear on the New England coast, sometimes by thousands. The birds are not rare south to Long Island, but farther south can be considered hardly more than stragglers, though recorded to South Carolina (Loomis).

The northern phalarope is a regular though not common migrant throughout the interior of the United States, and has been recorded from almost every State north of the Ohio River and south to Kansas (Goss) and New Mexico (Henry). There is no record as yet for any of the Gulf States. The species is a common migrant on the Pacific coast of America, and is sometimes abundant south to the coast of central California. Farther south it is less common, though recorded from San Jose, Lower California, in the fall (Brewster), and from the west coast of Mexico in the spring (Nelson). The few noted at Duenas, Guatemală, in August and September (Salvin), and those at Desamparados, Costa Rica (Salvin and Godman), complete the record for Central America.

Spring migration.—The northern phalarope was noted in the Bermudas March 21–22, 1848 (Hurdis), and March 8, 1852 (Reid). This is almost two months earlier than the species usually appears on the New England and Long Island coasts. Six years' observations at Montauk Point Light gives May 13 as the mean date of spring arrival—earliest, April 30, 1898 (Scott). Almost all the dates for the coast of Massachusetts are in May. The species arrives at the northern limit of its range about the middle of June. Some late records on the Atlantic coast are: Near Charleston, S. C., June 3, 1903 (Wayne); Montauk Point, New York, June 3, 1894 (Scott); on the coast of Maine to the middle of June (Job).

The northern phalarope was common at Sihuatanejo, on the western coast of Mexico, April 9, 1903 (Nelson); it usually appears on the coast of California in early May, reaches the mouth of the Yukon the middle of May, and was noted in the Kowak Valley, Alaska, May 22, 1899 (Grinnell); Point Barrow, June 11, 1883 (Murdoch), and June 15, 1898 (Stone); Walker Bay, Prince Albert Land, June 15, 1852 (Greely). Individuals are occasionally seen on the California coast in summer, but these are nonbreeders.

Eggs have been taken near Rupert House, Ontario, June 18, 1860 (Drexler); near Fort Anderson, June 16, 1862 (MacFarlane); at Kiska Island, Aleutians, June 30, 1873 (Dall); St. Michael, Alaska, June 1–20 (Nelson); and Kowak Valley, Alaska, June 28, 1898 (Grinnell).

Fall migration.—Returning migrants appear on the coast of central California less than six weeks after the northbound flocks disappear, and are common by the end of July. The great flocks pass during August, are less common in September, and cease in October—latest, Monterey, October 24, 1896 (Loomis). The average date of fall arrival at Montauk Point, New York, is August 28—earliest, August 5, 1893, latest, October 22, 1888 (Scott). The last one noted at Point Barrow was seen August 17, 1898 (Stone), and the species usually disappears from the mouth of the Yukon the last of September.

Records of migration in the interior of North America are not numerous. In southwestern Saskatchewan the fall migration opened July 13, 1906, with the arrival of a large flock, and a few days later the birds were abundant. This is only four weeks later than the departure of the northbound migrants, which had been seen in the vicinity in 1905 from May 29 to June 15, and the following year as late as June 14 (Bent). A remarkable flight of northern phalaropes occurred near Terry, Mont., in 1899; during the last ten days of May the birds were exceedingly abundant (Cameron).

Wilson Phalarope. *Steganopus tricolor* Vieill.

Breeding range.—The northern Mississippi Valley and the adjacent parts of Canada form the principal summer home of the Wilson phalarope. It breeds regularly as far east as northwestern Indiana (Lake County; Butler) and the islands near Green Bay shore (Schoenebeck). Macoun records that a pair nested at Dunnville, Ontario, near the northeastern shore of Lake Erie. Thence the breeding range extends west through central Iowa (Newton; Preston) and northern Colorado (Fort Collins; Cooke) to central California (Lake Tahoe; Bliss; and Las Banos; Mailliard). Instead of penetrating the Arctic regions, as do other phalaropes, this species finds the northern limit of its range in northern Manitoba (Lake Winnipeg; Thompson), central Saskatchewan (Osler; Colt), central Alberta (Edmonton; Macoun), northern Washington (Cheney; Johnson), and probably southern British Columbia.

Winter range.—The few winter records for this species come from South America—from central Chile (Philippi) and central Argentina (Durnford) south to Patagonia (Durnford) and the Falkland Island (Sclater). There is a single record in fall migration for western Brazil (Pelzeln). and one in May for central Peru (Berlepsch and Stolzmann). Three specimens were collected January 19, 1890, at Corpus Christi, Tex. (Sennett), but these were apparently laggards, for the species is not usually seen in Texas after September.

Migration range.—During the fall migration individuals wander eastward to the Atlantic coast and have been noted from South Carolina to Montreal. There is also one May record for Massachusetts (Baird, Brewer, and Ridgway) and one June record for Maine (Smith). The species seems to be unknown on the Atlantic coast between South Carolina and Argentina. The principal summer home is in western North America, and most of the species migrate south through Mexico and along both Mexican coasts, and then apparently cross directly to the west central coast of South America, since the species is unknown in Central America east of Guatemala and in South America north of Peru.

Spring migration.—The Wilson phalarope arrives in central Kansas on the average April 27, earliest April 23, 1885 (Kellogg); northern

Colorado about May 1; Chicago, Ill., average May 6; Heron Lake, Minn., average May 11, earliest May 8, 1889 (Miller); Hallock, Minn., average May 14, earliest May 9, 1896 (Peabody); Reaburn, Manitoba, average May 21, earliest May 16, 1898 (Wemyss); Osler, Saskatchewan, May 19, 1893 (Colt).

The earliest eggs in northern Iowa are deposited about May 20 (Anderson); eggs nearly hatched have been found in southern Saskatchewan June 7 (Macoun); young just hatching, June 16, at Lake Tahoe, California (Bliss), and at the same stage June 22, at Fort Klamath, Oregon (Merrill).

Fall migration.—The Wilson phalarope moves southward so early that most have left the breeding grounds soon after the middle of August; the last seen at Lanesboro, Minn., in 1885, was on September 13 (Hvoslef). The species continues passing through Mexico until October (Ferrari-Perez).

Avocet. *Recurvirostra americana* Gmel.

Breeding range.—The central western United States is the principal summer home of the avocet, but its breeding range extends north to central Wisconsin (Green Bay; Kumlien), southern Manitoba (Souris; Thompson), southern Saskatchewan (Osler; Colt), southern Mackenzie (Fort Rae; Ross), and central Oregon (Haines; Haines). It breeds south to northern Iowa (Hawarden; Anderson), northwestern Texas (Oberholser), southeastern New Mexico (Carlsbad; Bailey), and to Orange County, Calif. (Santa Ana; Grinnell). Many years ago this species was not rare on the Atlantic coast, and a few are known to have nested at Egg Harbor, N. J. (Giraud). At the present time it is a very rare visitor to any part of the Atlantic coast, and has scarcely been seen in New Jersey for the last twenty years. At various times in the past the avocet has been recorded along the coast from Florida (Cory) to southern New Brunswick (Chamberlain); one of the latest records is that of three birds seen September 13, 1896, at Ipswich Neck, Mass. (Kennard), and a single bird taken October 8, 1903, at St. Marys, Ga. (Arnow). The species occurs in the interior east of the Mississippi River, as a rare visitor from Louisiana (Audubon) to Ontario (Fleming), but is known to breed only in Wisconsin.

Winter range.—The avocet winters abundantly on the coast of Texas (Merrill) and in southern California (Newberry); sparingly through Chihuahua and Lower California and thence south to Guatemala (Salvin). During migration it has wandered a few times to Cuba (Gundlach), Jamaica (Gosse), and twice even to Barbados (Feilden).

Spring migration.—The month of April is the time of most activity in spring migration. By the latter part of this month the birds have reached South Dakota, and their average date of arrival at Great

Falls, Mont., is April 24 (Williams). They have even been noted at Salt Lake, Utah, as early as March (Baird), and at Ash Meadows, Nev., March 15, 1891 (Fisher). They appeared April 28, 1908, at Okanagan Landing, B. C. (Brooks), May 14, 1892, at Indian Head, Saskatchewan (Macoun), and June 1, 1864, at Fort Resolution, Mackenzie (Preble).

Eggs have been taken at Santa Ana, Calif., as early as May 3 and as late as July 6 (Grinnell); eggs nearly ready to hatch were found at Hawarden, Iowa, June 2, 1900 (Anderson), and at Crane Lake, Saskatchewan, June 9, 1894 (Macoun).

Fall migration.—The southward movement begins so early that by the last of August the first migrants have reached southern Mexico. Individuals have been seen in Nebraska as late as October 27, 1899 (Wolcott), and at Salt Lake, Utah, until a month later. Other late dates are: Cape Elizabeth, Me., November 5, 1878 (Brown); St. Mary Reservoir, Ohio, November 10, 1882 (Dawson); Oberlin, Ohio, November 4, 1907 (Jones); near New Orleans, La., November 12, 1889 (Beyer), and Johnsons Bayou, La., November 26, 1882 (specimen in United States National Museum).

Black-necked Stilt. *Himantopus mexicanus* (Müll.).

Breeding range.—The black-necked stilt is one of the very few shorebirds that breed in the United States and also in the Tropics. The breeding range extends north to Florida (Scott), Louisiana (Beyer), Texas (Merrill), southern Colorado (Henshaw), northern Utah (Allen), and central Oregon (Burns; Preble). More than half a century ago the species nested on Egg Island in Delaware Bay (Turnbull) and as late as 1881 still bred on the coast of South Carolina (Wayne). At the present time the bird is unknown along the whole Atlantic coast north of Florida, though formerly it has been noted locally to northern New England, and in September, 1880, one was seen at Mace Bay, New Brunswick (Chamberlain). In the interior of the United States the species is recorded as a straggler north to Ohio (Langdon), Michigan (Gibbs), Wisconsin (Hoy), Iowa (Rich), and Nebraska (Bruner, Wolcott, and Swenk), but is not known to breed east of the Rocky Mountains north of Texas. The southern limit of the breeding range is not yet well known. The species is a tolerably common resident of the entire West Indies and the whole northern coast of South America. It probably breeds south to central Peru and to the Lower Amazon. It breeds on the islands off the coast of Yucatan (Salvin), and probably on the coast of northeastern Mexico, and south to southern New Mexico (Carlsbad; Bailey) and southern California (Santa Ana; Grinnell). The early explorers of the West recorded it north to the Columbia River, but there are no definite breeding records so far north.

Winter range.—A few winter in southern Florida (Myers; Scott) and on the coasts of Louisiana (Beyer) and Texas (Corpus Christi;

Rhoads), and from southern Sinaloa (Mazatlan; Nelson) and southern Lower California (La Paz; Ridgway), south throughout Central America and the West Indies to central Peru (Santa Lucia; Taczanowski) and the mouth of the Amazon (Sclater and Salvin). The species winters on the Galapagos Islands, and possibly a few remain to breed (Rothschild and Hartert).

Spring migration.—The slight northward migratory movements of this species occur principally in April. Some dates of arrival are: Titusville, Fla., March 11, 1905 (Worthington); Sioux City, Iowa, April 20, 1902 (Rich); Omaha, Nebr., April 20, 1895 (Bruner, Wolcott, and Swenk); Escondido, Calif., April 13, 1896, April 15, 1897 (Hatch); Fresno County, Calif., April 5, 1890 (Eaton); Stockton, Calif., April 13, 1878 (Belding).

Eggs have been taken in southern California from early May to August, and at Salt Lake, Utah, May 22 (Ridgway). At Fort Garland, Colo., the young were just hatched June 21, 1873 (Henshaw).

Fall migration.—The latest dates in Nebraska are in early October, and the species has been noted at Riverdale, Calif., as late as November 19, 1891 (Eaton).

European Woodcock. *Scolopax rusticola* Linn.

The European woodcock is widely distributed in Europe and western Asia. It breeds in northern Europe and northern Asia from beyond the Arctic Circle south to England, Silesia, the Alps, the Himalayas, and the mountains of Japan; also on the Azores, Madeira and Canary islands. It winters from the British Islands, southern Europe and China, to northern Africa, India, and Formosa; it wanders occasionally to eastern North America, and has occurred in Loudoun County, Va., in 1873 (Coues); Chester County, Pa., the end of November, 1886 (Stone); one was taken near Shrewsbury, N. J., December 6, 1859 (Lawrence); one, September, 1889, somewhere in New Jersey (Warren); one, probably of this species, near Newport, R. I. (Baird, Brewer, and Ridgway); one at Chambly, Quebec, November 11, 1882 (Wintle); and one at St. John, Newfoundland, January 9, 1862 (Sclater).

Woodcock. *Philohela minor* (Gmel.).

Breeding range.—The woodcock breeds locally throughout most of its range in the United States, at least south to Jacksonville, Fla. (Brewster), the coast of Louisiana (Beyer), and to Neosho Falls, in southern Kansas (Goss). It will probably be found breeding in some of the bottomlands of eastern Oklahoma. The breeding range extends northward to Pictou, Nova Scotia (McKinlay); Prince Edward Island (Dwight); Chatham, New Brunswick (Baxter); the city of Quebec (Dionne); Bracebridge, Ontario (Macoun); the northern peninsula of Michigan, at Keweenaw Point (Kneeland); extreme northeastern Minnesota, at Elbow Lake (Roberts and Benner); and to Winnipeg, Manitoba (Thompson). The species has wandered north to Newfoundland (Bennett); was noted the end of August, 1879, at York Factory, Keewatin (Bell); and early in August, 1892, on Black River, Saskatchewan (Tyrrell), at latitude 59°—the most northern and also the most western record known. The woodcock has been seen several times in Colorado near Denver (Smith), though its regular range extends only to eastern South Dakota and eastern Kansas.

Winter range.—The woodcock remains in the north until driven away by frost, and the presence of unfrozen ground is the factor that determines the northern boundaries of its range through the winter. The larger part of the species winter in the Gulf States south at least to southern Florida (Myers; Scott) and to southern Texas (Victoria; Mitchell), but in Texas the species is very rare. Few woodcock winter north of latitude 37°, but these few are scattered at favorable localities over a wide area north to Long Island (Giraud), Grafton, Mass. (Mackay), and Vincennes, Ind. (Balmer). Woodcock have been taken several times in December at St. John, New Brunswick, but in each case they proved to be wounded birds (Gilbert). The species has been taken once in the Bermudas, in October, 1842 (Hurdis).

Spring migration.—Not only does the woodcock remain as far north as possible through the winter, but it also pushes northward in spring as soon as frost releases its feeding grounds. Average dates of spring arrival are: Renovo, Pa., March 22, earliest March 13, 1897 (Pierce); Long Island, New York, March 15, earliest March 10, 1898; central Connecticut, average of twelve years March 20, earliest February 24, 1891; eastern Massachusetts, average of eight years March 16, earliest February 13, 1890; southwestern Maine, March 29, earliest March 23, 1905; Halifax, Nova Scotia, March 25, earliest March 10, 1890 (Piers); St. John, New Brunswick, April 3, earliest March 21, 1898 (Banks); Pictou, Nova Scotia, April 12, earliest April 6, 1892 (McKinlay); city of Quebec, average of thirteen years April 17, earliest April 4, 1890 (Dionne); Hillsboro, Iowa, March 17, earliest March 15, 1898 (Savage); Waterloo, Ind., March 11, earliest March 1, 1906 (Link); Oberlin, Ohio, March 21, earliest March 10, 1902 (Jones); Petersburg, Mich., March 17, earliest March 2, 1887 (Trombley); Chicago, Ill., March 26, earliest March 22, 1884 (Wentworth); southern Ontario, April 2, earliest March 26, 1901; Ottawa, Ontario, May 1, earliest April 20, 1890 (White).

One of the most pronounced peculiarities of the woodcock is the early date at which it breeds, especially in the Gulf States. Young a few days old were found January 29, 1890, at Covington, La. (Beyer), which requires that the eggs should have been deposited in December. Young a week old were noted at Jacksonville, Fla., March 10, 1877 (Brewster); young at Sourlake, Tex., March 22, 1905 (Gaut); young

a week old at Falls Church, Va., April 18, 1897 (Riley); young just hatched, Norwich, Conn., April 5, 1888 (Rawson); young just hatched, Spearville, Ind., April 13, 1894 (Barnett); young, Oberlin, Ohio, April 19, 1901 (Baird); while eggs have been taken at Caper Island, South Carolina, February 13, 1903 (Wayne); Raleigh, N. C., March 9, 1892 (Brimley); Lower Cedar Point, Maryland, February 25, 1891 (Todd); Fallstown, Md., March 30, 1880 (Kirkwood); Lawrenceville, N. J., March 14, 1889 (Phillips); Rockland, Me., April 26, 1886 (Norris); Wheatland, Ind., March 14, 1882 (Ridgway); and at Vermilion, S. Dak., April 21, 1884 (Agersborg).

The average date of the last woodcock seen at Ottawa, Ontario, is October 19, latest October 23, 1885 (White); average southern Ontario October 21, latest November 6, 1889; usually leave Montreal, Canada, about October 20, but were seen in 1880 to December 16 (Wintle); St. John, New Brunswick, average date of the last seen November 10, latest November 13, 1888 (Banks); Halifax, Nova Scotia, average November 6, latest December 4, 1895 (Piers); southwestern Maine, average of nine years October 22, latest November 23, 1900.

European Snipe. *Gallinago gallinago* (Linn.).

The European snipe is an Old World species breeding in Iceland and throughout northern Europe and Siberia and south to the Alps, southern Russia, and Turkestan. It winters south to northern Africa and to China, Formosa, and the Philippines. It has been taken twice in the Bermudas—December 24 and 29, 1847 (Reid), and three times in Greenland—at Nanortalik, September 6, 1840; at Fiskenaes, October, 1845, both on the west coast of Greenland (Winge); and the third instance was May 29, 1902, at Angmagsalik, on the eastern coast (Helms). A specimen in the British Museum is marked as having come from Canada, but nothing is known of its history.

Wilson Snipe. *Gallinago delicata* (Ord).

Breeding range.—The northern limit of the breeding range of the Wilson snipe extends from Newfoundland (Reeks) and northern Ungava (near Fort Chimo; Turner) to northern Mackenzie (Dease River; Hanbury) and (Fort Anderson; MacFarlane), northern Yukon (La Pierre House; Catalogue United States National Museum), and northwestern Alaska (Kowak River; Grinnell), apparently following closely the limit of trees. Snipe have been noted a few times on the west coast of Greenland (Winge), but there is nothing to prove that they breed in that country. The species breeds south to New Jersey (Trenton; Abbott), northern Indiana (Davis Station; Deane), northern Illinois (Waukegon; Nelson), northern Iowa; (Union Slough, Kossuth County; Anderson), southern Colorado (San Juan County; Drew), northern Nevada (Ridgway), and northern California (Eagle Lake; catalogue egg collection, United States National Museum).

Winter range.—During the winter season some Wilson snipe leave the United States and pass even to northern South America, on the east side to Rio Janeiro (Pelzeln) and on the west to Medellin, Colombia (Sclater and Salvin). A few winter in the Lesser Antilles and many in Jamaica, Cuba, and the Bahamas. The species is common in Mexico and Guatemala, less common in the remainder of Central America. A large part of the species winters in the southern United States, where it was formerly enormously abundant. No exact limit can be given to the northern range in winter. The Wilson snipe can not live where the ground is frozen. Hence the normal northern winter limit would extend from North Carolina through Arkansas to New Mexico and on the Pacific slope to northern California. But many snipe pass the winter much north of the zone of frozen ground, feeding about streams or springs. A few can be found almost every winter on Cape Cod, Massachusetts (Mackay), and a pair were seen during January and February, 1896, as far north even as Wolfville, Nova Scotia (Tufts). From the Mississippi Valley snipe are reported as wintering north to northern Illinois and northern Nebraska (Bruner, Wolcott, and Swenk), while in the Rocky Mountains of Colorado at 8,000 feet near Sweetwater Lake, the presence of warm springs has enabled them to remain the entire winter, though the air temperature fell to —30° F. (Gilmore). They have been known also to winter in northern Montana (Coubeaux) and northern Washington (Snyder). A few snipe appear almost every fall in the Bermuda Islands (Jardine) and sometimes remain through the winter, though usually they are rare in spring.

Spring migration.—A series of nearly twenty years of observations near Alexandria, Va., gives the average date of arrival as March 8, with the earliest February 17, 1897 (Greenwood); the species is most common the last week in March. The average date of arrival in central New Jersey is March 22, earliest March 4, 1877. Some other dates of arrival are: Central Connecticut, average March 23, earliest March 18, 1894; eastern Massachusetts, average April 2, earliest March 21, 1887; southwestern Maine, average April 27, earliest April 14, 1897; Scotch Lake, New Brunswick, earliest April 5, 1907 (Moore); Pictou, Nova Scotia, average April 19, earliest April 11, 1889 (Mackinlay); city of Quebec, average April 23, earliest April 18, 1899 (Dionne).

The movements in the Mississippi Valley are at closely corresponding dates: Central Missouri, average date of arrival March 13, earliest February 17, 1897; Oberlin, Ohio, average March 28, earliest March 19, 1897 (Jones); Chicago, Ill., average April 3, earliest March 17, 1894 (Blackwelder); southern Michigan, average April 3, earliest March 21, 1893; southern Ontario, average April 15, earliest April 1, 1900; Ottawa, Ontario, average April 26, earliest April 12, 1902

(White); Keokuk, Iowa, average March 23, earliest March 13, 1900 (Currier); central Iowa, average March 22, earliest March 11, 1897; southern Wisconsin, average March 30, earliest March 18, 1894; Heron Lake, Minn., average April 5, earliest April 1, 1888 (Miller); central South Dakota, average April 11, earliest April 7, 1890; Aweme, Manitoba, average April 24, earliest April 18, 1896 (Criddle); central Montana, average April 4, earliest March 27, 1894; Rathdrum, Idaho, average April 14, earliest April 8, 1899 (Danby); Okanagan Landing, British Columbia, April 8, 1907 (Brooks); Bulyea, Alberta, April 27, 1904 (Huck); near Fort Providence, Mackenzie, May 2, 1904, and May 1, 1905 (Jones); Fort Simpson, Mackenzie, May 10, 1904 (Preble); Nushagak, Alaska, April 25, 1882 (McKay); Fort Reliance, Yukon, May 2 (Sharpe); Fort Kenai, Alaska, May 5, 1869 (Bischoff); Nulato, Alaska, May 21, 1868 (Dall); Kowak River, Alaska, May 22, 1899 (Grinnell).

In southern Louisiana the average date of departure is April 19, latest April 30, 1887; Raleigh, N. C., average April 26, latest April 28, 1898 (Brimley); central Nebraska, average April 27, latest May 18, 1899; Chicago, Ill., average May 4, latest May 6, 1904 (Dearborn); Oberlin, Ohio, average May 5, latest May 16, 1904 (Jones). Some late dates of the last seen are: San Jose, Costa Rica, February 16, 1890 (Cherrie); Gainesville, Fla., April 15, 1887 (Chapman); Lake Ellis, N. C., May 9, 1906 (Brimley); Washington, D. C., May 4, 1900 (Preble); Bay St. Louis, Miss., May 10, 1902 (Allison); Dallas, Tex., May 1, 1898 (Mayer); Long Pine, Nebr., May 18, 1899 (Bates).

Eggs have been taken at Meadville, Pa., May 13, 1875 (Huidekoper); young about two days old at Trenton, N. J., May 26, 1876 (Abbott); eggs at Branchport, N. Y., May 20, 1896 (Stone); near Waukegan, Ill., April 24, 1896 (Deane); Davis Station, Ind., April 24, 1898 (Deane); Pewaukee, Wis., May 12, 1871 (Goss); Elk River, Minn., May 24, 1884 (Bailey); Minneapolis, Minn., May 14, 1887 (Cantwell); American Fork, Utah, April 29 (Johnson); Fort Klamath, Oreg., May 20, 1883 (Bendire); Yukon River, Alaska, May 28, 1861; Fort Resolution, Mackenzie, May 30, 1864 (Lockhart); Shumagin Islands, Alaska, June, 1895 (Call).

Few of the shorebirds suffer so much from spring shooting as the Wilson snipe. All winter long in the swamps of the southern States it is persecuted by hunters, and as it moves northward it meets a fusillade throughout its whole course. In the central parts of the South shooting is at its height early in March, and just south of the breeding range the bulk of the birds pass early in April.

Fall migration.—July birds south of the breeding grounds are very rare, though they have been noted at Bay St. Louis, Miss., on the very early date of July 29, 1901 (Allison). Some dates of arrival in the fall are: Washington, D. C., August 30, 1894 (Richmond); Frogmore, S. C., September 16, 1885 (Hoxie); northern Florida, average September 26, earliest September 20, 1904 (Williams); southern Louisiana, average August 29, earliest August 25, 1901 (Ballowe); Lincoln, Nebr., August 7, 1900 (Wolcott); San Bernardino River, Sonora, August 19, 1893 (Mearns); San Jose del Cabo, Lower California, August 28, 1887 (Brewster); San Jose, Costa Rica, October 9, 1889 (Cherrie;) Bermudas, September 13 (Reid); Barbados, West Indies, October 11, 1886 (Manning). The hunter near Newport, R. I., secured scarcely a third as many snipe in the fall as in the spring—466 birds in the eight years; earliest July 30, 1870, latest November 14, 1871. The average dates were August 19 to October 27 (Sturtevant).

Some dates of the last seen are: Near Jasper House, Alberta, September 13, 1896 (Loring); Aweme, Manitoba, average October 11, latest November 7, 1907 (Criddle); Lanesboro, Minn., October 31, 1887 (Hvoslef); Keokuk, Iowa, average November 23, latest November 28, 1889 (Currier); Oberlin, Ohio, latest November 22, 1890 (Jones); Ottawa, Ontario, average November 2, latest November 18, 1900 (White); Chicago, Ill., average October 31, latest November 13, 1885 (Holmes); St. John, New Brunswick, November 5, 1889 (Banks); Halifax, Nova Scotia, average November 23, latest December 3, 1894 (Piers); southwestern Maine, average October 21, latest November 8, 1873; Montreal, Canada, average October 30, latest November 13, 1897 (Wintle).

Great Snipe. *Gallinago media* (Latham).

The great snipe is a species of wide distribution in the Eastern Hemisphere. Its breeding range extends from the Scandinavian Peninsula to the Yenisei River of Siberia and from Prussia north to at least 71° north latitude. The winter home is from the Mediterranean to South Africa, and during its migration the species occurs from Great Britain to Persia.

The only record for the Western Hemisphere is that of a skin presented by the Hudson's Bay Company to the British Museum (Sharpe). There is no reason for doubting that the specimen was taken in Canada, but no definite locality can be assigned.

Dowitcher. *Macrorhamphus griseus* (Gmel.).

Breeding range.—The nest and eggs of the dowitcher are not yet known to science, nor has the species been seen in summer at any place where it was probably breeding. The dowitcher is a common migrant on the coasts of New Jersey, New York, Rhode Island, and Massachusetts, and in fall is sometimes very abundant. Farther north its numbers decrease: New Hampshire, tolerably common in fall, no spring records; Maine, tolerably common spring and fall; Quebec, rare migrant; New Brunswick, no records; Nova Scotia, once (Sharpe); Prince Edward Island, once; Ungava, a few in August, 1860, at Henley Harbor (Coues), one June 10, 1863, at Fort Chimo (Turner). North of Ungava, the only record is that of a single accidental occurrence at Fiskenaes, Greenland (Reinhardt). Evidently the dowitcher does not breed in any numbers on the eastern coast of Ungava. The probability that it does not breed there at all is strengthened by the fact that several first class observers, who during the fall migration were in the Gulf of St. Lawrence, did not see any of the birds. It undoubtedly does not go into northeastern Keewatin and the islands of the Province of Franklin, for it is not reported by the various expeditions that have traveled and wintered in those districts, while the specimens taken on the west coast of Hudson Bay belong to the form called *scolopaceus*. The only district left for the breeding ground is the interior of Ungava and the eastern shore of Hudson Bay.

Winter range.—The dowitcher ranges south in winter through the West Indies to the northern coast of South America and to the Amazon River (Sharpe). It remains at least as far north as northern Florida (Worthington) and probably a few as far west on the Gulf coast as Louisiana.

Spring migration.—The first one seen in 1890 at Darien, Ga., was on March 20 (Worthington); the average date of arrival on the southern coast of South Carolina is March 23, earliest March 17, 1885 (Hoxie); central North Carolina, average April 30; Pea and Bodie Islands, North Carolina, April 27, 1905 (Bishop); Long Beach, New Jersey, May 13, 1877 (Scott).

The species is rare west of the Allegheny Mountains, but a few specimens have been reported: Near Chicago, Ill., May 6, 1893 (Woodruff); Toronto, Ontario, not common May 16–31. This last locality seems to be about as far west as the dowitcher occurs regularly, though formerly it probably ranged west to Lake Michigan.

The species is not uncommon on the coast of Florida throughout the summer, but the individuals remaining so far south do not assume the breeding plumage (Scott). Migrants are common in Florida until the last week in May, and on the coast farther north the last leave for the breeding grounds about the first of June (Scott).

Fall migration.—The first migrants appear on the New England coast early in July: Edgartown, Mass., July 4, 1891 (Worth); near Newport, R. I., July 7, 1871 (Sturtevant); Long Beach, New Jersey, July 6, 1877 (Scott); Bone Island, Virginia, July 14, 1880 (Ridgway); Erie, Pa., July 19, 1892 (Todd); Pea and Bodie islands, North Carolina, July 7, 1904 (Bishop); Barbados, West Indies, August 24, 1888 (Feilden). A market hunter near Newport, R. I., shot 1,058 dowitchers during 1867–1874—extreme dates July 7, 1871, and October 20, 1870. and average date of arrival July 17 (Sturtevant). Some dates of the last seen are: Henley Harbor, Ungava, August 21, 1860 (Coues); Montreal, Canada, September 27, 1892 (Wintle); Toronto, Ontario, September 15, 1889 (Fleming).

Long-billed Dowitcher. *Macrorhamphus griseus scolopaceus* (Say).

Breeding range.—The long-billed dowitcher was found as a fairly common breeder in the Anderson River region, Mackenzie (MacFarlane), and breeds thence west along the Arctic coast to Point Barrow, Alaska (Murdoch), though not commonly. It is an abundant breeder at the mouth of the Yukon and on the shores of Norton Sound (Nelson). The species is known from the northern coast of eastern Siberia (Palmen), but as yet has not been found there breeding.

Winter range.—The principal winter home seems to be the shores of the Gulf of Mexico; the species is common as far east as the Gulf coast of Florida (Scott), and a few pass on to Cuba (Lawrence). It is common in Mexico and Guatemala, has been recorded as far south as Costa Rica (Frantzius), and it is probably this form that occurs in Panama (Lawrence).

Some form of the dowitcher occurs on the coast of Ecuador (Salvadori and Festa) and in Peru as far south as Tumbez (Taczanowski), but whether the eastern or western form has not yet been ascertained.

Migration range.—There is a decided easterly fall migration which brings quite a number of long-billed dowitchers to the Atlantic coast of the United States. They are fairly common from Long Island southward, and a few have been taken on the coasts of Rhode Island (Howe and Sturtevant) and Massachusetts (Brewer); and one, August 12, 1891, at Hamilton, Ontario (Fleming). This is the form common in the Mississippi Valley and it is also more common than *griseus*, at least as far east as Ohio. There is one record of its accidental occurrence in Japan (specimen in United States National Museum).

Spring migration.—The long-billed dowitcher is only a straggler in spring on the Atlantic coast, but has been recorded at Washington, D. C., in April, 1884 (Smith and Palmer); Cape May, N. J., May, 1848 (specimen in United States National Museum); while on Long Island, New York, a very early individual was seen March 20 (Lawrence). The species normally reaches northern Indiana and northern Illinois late in April, but one was taken in 1889 at English Lake, Indiana, on the early date of March 11 (Butler). It was enormously abundant along the west shores of Lake Michigan in the early days of the settlement of the country, but of late years has become quite rare. Some dates of arrival farther west are: Fort Brown, Tex., March 27, 1853 (Cassin); Corpus Christi, Tex., March 24, 1889 (Sennett); Lawrence, Kans., April 19, 1873 (Snow); Omaha, Nebr., April 28, 1856 (Cassin); Cheyenne, Wyo., May 3, 1889 (Bond); Fort Kenai, Alaska, May 4, 1869 (Osgood); St. Michael, Alaska, May 18, 1877 (specimen in Sennett collection); Fort Anderson, Mackenzie, May 28, 1865 (MacFarlane); Point Barrow, Alaska, June 19, 1882 (Murdoch).

Eggs were taken at St. Michael, Alaska, May 23, 1880 (Nelson); near Fort Anderson, Mackenzie, June 21, 1864, and June 15, 1865 (MacFarlane); incubating birds were taken at Point Barrow, Alaska, June 28, 1883 (Murdoch).

Fall migration.—Southward-bound migrants were abundant July 31, 1900, on the west shore of Hudson Bay near Fort Churchill (Preble), and this must have been nearly the last of the migration, for none were seen after three days later. By this date the earliest migrants were already far south, as shown by the following dates of arrival: Fort Kenai, Alaska, July 20, 1869 (Osgood); Tulare Lake, Calif., July 8, 1907 (Goldman); Hay Creek, Saskatchewan, July 3, 1906 (Bent); Denver, Colo., July 24, 1873 (Henshaw); Long Island, New York, July 23, 1884 (Dutcher); Pea and Bodie islands, North Carolina, July 7, 1904 (Bishop); San Mateo, Oaxaca, August 12, 1869 (specimen in United States National Museum).

The last were seen at Point Barrow, Alaska, August 17, 1882 (Murdoch), and August 26, 1897 (Stone); Chilliwack, British Columbia, October 29, 1888 (Brooks); Hutton Lake, Wyoming, October 14, 1899 (Knight); Mimbres, Ariz., October 22, 1873 (Henshaw); Souris River, North Dakota, October 1, 1873 (Coues); Lincoln, Nebr., October 20, 1900 (Wolcott); Long Island, New York, October 15, 1884 (Lawrence).

Stilt Sandpiper. *Micropalama himantopus* (Bonap.).

Breeding range.—Information concerning the nesting of the stilt sandpiper is very meager. Several sets of eggs and some young birds were taken at Franklin Bay on the Arctic coast of Mackenzie and one nest was found at Rendezvous Lake, a few miles back from the coast (MacFarlane). A Biological Survey party found young of the year (probably migrants) July 19, 1900, near York Factory, Keewatin, and noted old birds August 12 near Cape Eskimo (Preble). The young were probably hatched somewhere on the Barren Grounds north of York Factory. The record from these regions seems to be the only data so far obtained bearing on the summer home of the species. It is probably safe to say that the breeding range extends along the Arctic coast and the adjoining tundras from near the mouth of the Mackenzie to the tree limit on the western shores of Hudson Bay.

Winter range.—If the winter home is to be determined solely by specimens noted or taken in winter, then it must be said that the winter home of the stilt sandpiper is unknown; for there seem to be only two records of the species anywhere for the months of November, December, and January. One of these is in Mexico (Ferrari-Perez) and the other in Texas (Sennett), and probably both were accidental occurrences. This is one of the rarer sandpipers and the total number of individuals is not great. The species is apparently most common on the Atlantic coast, while a smaller number occur around the Great Lakes and along the eastern edge of the Great Plains in the line leading to the coast of southern Texas. The winter home is therefore to be sought in a southerly direction from the eastern United States. The total records for the whole of Central America are only three, one each in Guatemala (Sclater and Salvin), Nicaragua (Sharpe), and Costa Rica (Zeledon); while the species is recorded as a tolerably common migrant in each of the Greater Antilles and in six islands of the Lesser, but as more common in the Lesser than the Greater Antilles. This latter fact indicates that the principal winter home lies along the Atlantic coast of South America, although records to substantiate this supposition are lacking. The South American records are as follows: Cienega, Colombia, September 13 (Allen); Barbahoyo (Sclater) and Vinces (Salvadori and Festa), Ecuador, each in September; Yquitos, Peru, September and August (Sharpe); Chorillos, Peru (Taczanowski); Nauta, Peru, September, October, March, and April (Sclater and Salvin); Falls of the Madeira, Bolivia, October (Allen); Ilha Grande, Brazil, August (Sharpe), and Matto Grosso, Brazil, October (Pelzeln). There remain the records of specimens taken in Chile (Sharpe) and at Colonia, Uruguay (Sharpe), without date of capture. Present knowledge is therefore summed up by the statement: It winters in South America, south to Chile and Uruguay. One specimen is recorded as taken at Laguna del Rosario, Mexico, in January (Ferrari-Perez), and one at Corpus Christi, Tex., January 19, 1890 (Sennett). As already stated, it is not probable that the stilt sandpiper winters regularly at either of these localities. One taken February 8, 1892, at Manzanillo, Mexico, by Nelson and Goldman of the Biological Survey, may have been an early spring migrant.

Spring migration.—The species is rare in spring migration along the Atlantic coast—indeed, the records are so few that it might be called occasional or even accidental. Some of these records are: Jamaica, April (March); Cuba, April (Gundlach); Sullivan Island, South Carolina, May 11, 1885 (Sennett); Cape Hatteras, North Carolina, May 19, 1898 (Pearson); Long Island, New York, once in May (Chapman), one June 16, 1863 (specimen in United States National Museum); Rhode Island, May 9, 1895 (Howe and Sturtevant). The principal route of spring migration seems to be up the Mississippi Valley and particularly along the direct course from the coast of Texas to Great Slave Lake. Most of the dates of arrival are in May. Some of the more northern are: Indian Head, Saskatchewan, May 18, 1892 (Macoun); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); Cheyenne, Wyo., May 25, 1889 (Bond); Fort Chipewyan Alberta, June 6, 1893 (Russell); the last one noted at Indian Head in 1892 was June 5 (Macoun). Eggs were taken on Anderson River, Mackenzie, June 24, 1863; at Rendezvous Lake, June 27, 1865; and young at Franklin Bay, July 8, 1865 (MacFarlane).

Fall migration.—That fall migration begins as early as possible is evidenced by the presence of the species in Peru and Brazil by August. It is said to arrive on Grenada and Barbados, West Indies, in July, and the earliest records on the Atlantic coast of each of the New England States is in the same month—earliest July 6, 1874, near Newport, R. I. (Sturtevant). As late as 1879 Doctor Brewer stated that it was not yet known to be a regular migrant in this region, while a gunner near Newport, R. I., had listed 279 individuals, shot in 1867–1874, the dates ranging from July 6 to September 19 (Sturtevant), but these records were not published until 1901. Along this part of its course the species is most common in August, and most have departed by early September. Some late dates are: Newfoundland, one September, 1867 (Reeks); St. John, New Brunswick, September 8, 1881 (Chamberlain); Portland, Me., October 13, 1906 (Eastman); Key West, Fla., November 1, 1888 (Scott); Barbados (Feilden), Grenada (Wells), and in Trinidad (Leotaud), a few remain until October. The species has been noted as casual or accidental in Colorado (Thorne), Montana (Coues), British Columbia (Brooks), and Bermuda (Hurdis).

Knot. *Tringa canutus* Linn.

Breeding range.—The summer range of the knot is almost circumpolar, extending from Iceland across the whole of Arctic America and westward to northwestern Siberia. The species has also been taken once in Spitzbergen, but seems in general to be lacking in the Arctic regions north of Europe. There is every reason for believing that the species breeds locally throughout its summer range, but authentic eggs are a great desideratum. Eggs claimed to be positively identified have been collected at four localities: Fort Conger, Grinnell Land, June 9, 1883 (Greely); Disko, Greenland, 1875 (Seebohm); Iceland, June 17, 1898 (Ottosson); Taimyr Peninsula, Siberia, July 6, 1901 (Dresser). These eggs differ so much in size, shape, and coloration that some of them must have been wrongly identified. One of the latest expeditions into the Arctic regions saw young at Goose Fiord, latitude 76° 30′ N., but found no eggs (Sverdrup). The species was found breeding commonly at Igloolik on Melville Peninsula, latitude 69°, in the summer of 1823 (Parry), but none of the many eggs collected were preserved. Three years earlier it had been noted as an abundant breeder on Melville Island (Sabine). At that time the bird was undoubtedly many times more common than now. The Iceland record at 66° latitude is the most southern breeding record, and nestlings have been taken on Grinnell Land at 82° 44′ latitude. These represent the extremes of the breeding range.

Winter range.—The breeding knots of Siberia go south in winter to southern Africa, India, Australia, and New Zealand; those from Arctic America winter in South America, south to Tierra del Fuego, where they were found to be common February, 1895 (Schalow). The species is recorded locally from the coasts of South America, but present data are not sufficient to define the northern limits of the winter range. It is not probable that the knot winters regularly anywhere north of South America, and all records to the contrary, as the three seen in January, 1890, on Muskeget, Mass. (Mackay), must be considered as accidental. On Barbados the species has been noted as late as December 27, 1886 (Manning), but it is there considered to be only a migrant.

Migration range.—The principal migration route is along the Atlantic coast, where the knot is known locally from Florida to Newfoundland, and was formerly quite common. There are notable gaps in the records of this species. It is known locally as a tolerably common migrant throughout the Mississippi Valley east of the ninety-eighth meridian, but apparently these Mississippi Valley birds pass north and a little east to Hudson Bay and thence to the Arctic islands, for the species is unrecorded in the whole interior of Canada west of Hudson Bay, and has not been found even on the Arctic coast of Mackenzie. Southward there is another break in the records, for the specimen taken April 13, 1904, at Rivera, Veracruz (Piper), seems to be the first and only record for Mexico, and there is none for Central America, though the species is moderately common in Texas south to Corpus Christi (Sennett). A few individuals of this species have been seen in migration on the Pacific coast from San Diego, Calif. (Dwight), to Cape Blossom, Alaska (Grinnell).

Spring migration.—The knot arrives on the United States coast in April, but the larger flocks come about the middle of May, and there is no apparent difference in the dates for the whole coast from Florida to Massachusetts. An early date is March 28, at Grand Isle, Louisiana (Beyer, Allison, and Kopman). Near the northern limit of the range some dates of arrival are: Point Barrow, latitude 71° 20′ N., May 30, 1883 (Murdoch); Fort Conger, latitude 81° 40′ N., June 3, 1883 (Greely); Floeberg Beach, latitude 82° 30′ N., June 5, 1876 (Feilden), while far to the southward at Winter Island, latitude 66° N., the first was not noted until June 16, 1822 (Parry), and the next year at Igloolik, a few miles farther north, not until June 14 (Parry).

Fall migration.—Birds from the north arrive on the coast of Massachusetts, on Long Island, and in some seasons, even on the coast of South Carolina (Wayne), by the middle of July; the first was seen at the Olympiades, Wash., July 7, 1905 (Dawson). It seems scarcely possible that these early arrivals can have bred the same year, for earliest dates of young are in July and that at places 2,000 miles or more to the northward. August is the month of principal migration from Maine to South America, and this month also witnesses the departure from the breeding grounds. The last one seen at Floeberg Beach was August 29, 1875 (Feilden); Point Barrow, August 17, 1898 (Stone); Homer, Alaska, August 23, 1901; Winter Island, Melville Peninsula, August 17, 1822 (Greely). During the summer of 1822 the entire stay of the knot on Winter Island was only sixty-two days—one of the shortest nesting periods of any species.

Purple Sandpiper. *Arquatella maritima* (Brünn.).

Breeding range.—The purple sandpiper is principally a bird of the Old World, breeding on the Arctic coast and islands from northwestern Siberia to Iceland. In Greenland it is known on the east coast to Shannon Island, latitude 75° N. (Schalow); and on the west to Thank God Harbor, 81° 40′ N. (Bessels); and probably it breeds at least as far north as latitude 72°. A few were seen at Fort Conger, on Grinnell Land (Greely); several at various times in the fall around Wellington Channel (McCormick); and the species was found common in summer on Banks (Armstrong) and Melville (Ross) islands. The Banks Island record at latitude 74° N., longitude 118° W., marks the extreme northwestern range of the species. To the westward of this it is replaced by *couesi*. The southern limit of the breeding range appears to extend from the southern end of Greenland to the base of the Melville Peninsula, and possibly to the northern shores of Hudson Bay. The species breeds most commonly on the shores of Baffin Bay and Davis Strait.

Winter range.—The purple sandpiper remains the farthest north in winter of any of the shorebirds. It is said to winter sometimes even in southern Greenland (Hagerup), and it is common in winter from Nova Scotia (Sharpe) and New Brunswick(Macoun) southward to the coast of Rhode Island (Howe and Sturtevant). It is a rare but regular winter visitant to Long Island, New York (Dutcher), and has occurred casually thence south to the Bermudas (Reid), Georgia (Sennett), and Florida (Scott). The species is rare anywhere away from the ocean, but has been noted a few times in the vicinity of the Great Lakes.

Spring migration.—Some dates of spring arrival are: Winter Island, June 10, 1822 (Greely); Igloolik, June 14, 1823 (Greely); Cambridge Bay, June 10, 1853 (Greely); Bay of Mercy, June 3, 1852 (Armstrong); Cumberland Sound, June 4, 1878 (Kumlien); Prince of Wales Sound, Ungava, May 27, 1886 (Payne); west coast of Greenland at latitude 72° N., May 29, 1850 (Sutherland). The last usually desert the New England coast in March.

Fall migration.—Occasionally a stray bird appears in September on the New England coast, but the main flocks do not arrive until

November or December. The species is not late in deserting the far North, as evidenced by the following dates of the last ones seen: Thank God Harbor, Greenland, September 11, 1871 (Bessels); Possession Bay, Franklin, September 1, 1818 (Sabine); Wellington Channel, August 28, 1852 (McCormick). At Cumberland Sound a few remained in 1877 until November (Kumlien).

Aleutian Sandpiper. *Arquatella maritima couesi* Ridgw.

The western coast of Alaska and the Aleutian Islands seem to be the principal home of the Aleutian sandpiper. It breeds throughout the whole of the Aleutian Chain, east to the Shumagin Islands (Dall); and also to the westward on the Commander Islands of Asia (Stejneger). It winters on the Aleutians and south along the mainland of Alaska to Sitka (Bischoff). A few of the breeding birds of the Commander Islands remain throughout the winter, but most of them go south as far as the Kurile Islands (Sharpe).

Early in August, when the young are strong of wing, great flocks move north and appear on the west coast of the mainland of Alaska, at least as far north as Kotzebue Sound (Nelson); they occur also inland to Nulato (Dall), and on the Asiatic side at least to Plover Bay (Dall). This northward migration takes them also to the Pribilof Islands (Seale). They remain in this northern part of the range until driven south by the gathering ice; the last leave Norton Sound about the middle of October (Nelson). The earliest records of eggs taken on Bering Island are about the middle of May (Stejneger), and on Unalaska Island the first week in June (Reed).

Pribilof Sandpiper. *Arquatella maritima ptilocnemis* (Coues).

The name Pribilof sandpiper indicates the principal breeding place, but in addition, the species has been found breeding on the islands of St. Lawrence (Nelson), St. Matthew (Elliott), and Hall (Grinnell). It has been taken from July 17 to August 29 on the shores of Norton Sound (McGregor), but there is nothing to indicate that it breeds in the vicinity, and its occurrence there is probably due to a northward migration after the breeding season. The main winter home has not yet been ascertained, and the only winter records to date are those of a few seen in December and January at Portage Bay, near the base of the Alaska Peninsula (Hartlaub). In spring migration the Pribilof sandpiper has been taken April 1–14 at Nushagak, Alaska (Palmer), and in fall migration August 5–14 near Unalaska Island (McGregor). Eggs have been found on the Pribilof Islands from June 19 to July 6 (Prentiss).

Sharp-tailed Sandpiper. *Pisobia aurita* (Latham).

The breeding range of the sharp-tailed sandpiper is not well known. The bird occurs in summer on the north shore of Siberia at Cape Waukarem (Nelson) and the Chuckchi Peninsula (Palmen), and this is probably the principal breeding range. The species winters in Australia and New Zealand and migrates through the Commander Islands, Japan, China, and the Malay Archipelago.

All the records for North America seem to be during the fall migration, at which period—crossing to America on the way to its winter home in Asia—it is fairly common in Alaska on the shores of Norton Sound, and has been noted north to Port Clarence and Hotham Inlet (Nelson). It has been taken a few times on the Pribilof Islands, once on Unalaska Island (Bishop), once on Queen Charlotte Islands (Fannin), and once on Vancouver Island (Brooks). The period of occurrence on the coast of America extends from August 17, when the first was seen on the Pribilof Islands (Grinnell), to October 12, the date of the last seen in Norton Sound (Nelson). The two individuals taken December 27, 1897, on Queen Charlotte Islands (Fannin), were probably stragglers.

Pectoral Sandpiper. *Pisobia maculata* (Vieill.).

Breeding range.—The principal known summer home of the pectoral sandpiper is the coast of northwestern Alaska, from the mouth of the Yukon (Nelson) to Point Barrow (Murdoch). The principal authority on the birds of the Arctic coast east of the Mackenzie is MacFarlane, and he reports that the pectoral sandpiper was rare in the vicinity of Fort Anderson and Franklin Bay, and that he was never able to find the nest. This must have been a local peculiarity of distribution, for Edward A. Preble, of the Biological Survey, found the species abundant in August, 1900, on the barren grounds of the western shore of Hudson Bay; the species is also a common fall migrant on the coast of Ungava (Coues). Undoubtedly all these birds of Keewatin and Ungava nest along the neighboring Arctic coast, where, indeed, the eggs have been taken at Cambridge Bay, Franklin (Collinson).

Winter range.—In winter the species passes to southern South America, at least as far south as Port Desire, Argentina, latitude 40° 30′ S. (Sharpe), and to Antofagasta, Chile, 23° 30′ S. (Philippi). It winters in northern Argentina (Durnford) and as far north as Bolivia (Salvadori) and Peru (Sharpe). Though confined in summer to the seacoast, yet in its migrations it has been noted in Colorado at 13,000 feet (Morrison), and in its South American winter home it is not uncommon in the mountains to 12,000 feet (Sclater).

Migration range.—The pectoral sandpiper has a very pronounced southeastward migration in the fall. How far west the range extends in the Arctics is not yet known, but the bird has been found in late July and August along the northern coast of Siberia as far west as the Taimyr Peninsula (Palmen), and it may sometimes be found on this coast as a breeder. From these far western localities, it starts east and south along the Alaska coast, and a few visit the Pribilof Islands (specimen in United States National Museum) and the eastern

Aleutians (Bishop), but the species is nowhere common on the Pacific coast south of Alaska, showing that most of the Alaskan and Siberian birds cross the Rocky Mountains and migrate southeastward to the winter home. Still some pass south along the Pacific coast to Washington (Bowles); Mill Valley Junction, Calif., September 14, 1896 (Mailliard); Farallon Islands, September 4, 1884 (specimen in United States National Museum); several at Santa Barbara, Calif., September 8–20 (Bowles); and the species is fairly common during fall migration in the Cape Region of Lower California (Brewster).

The species is well known as a migrant on the west coast of Greenland as far north as Upernivik, latitude 73° (Winge). It is a common migrant throughout the whole of North America east of the Rocky Mountains, and of the West Indies and Central America. It is strangely rare in the northern part of South America, where it seems to be unrecorded in Venezuela and Guiana, and to have been recorded only once from Colombia (Allen). It is common in migration in Ecuador and Brazil.

Spring migration.—The start from the South American winter home must be very early—February, or more likely January—for the average date of arrival at Raleigh, N. C., is March 23; earliest March 21, 1889 (Brimley). Raleigh is full 2,000 miles from the nearest boundary of the winter range, and probably these birds had already traveled over 3,000 miles when they appeared at Raleigh. Some other spring dates are: Beaver, Pa., average April 4, earliest April 1, 1890 (Todd); Erie, Pa., March 23, 1895 (Todd); New Orleans, La., March 7, 1896 (Allison); Hidalgo, Tex., March 16, 1890 (Sennett); St. Louis, Mo., March 17, 1884 (Widmann); Chicago, Ill., average of seven years, March 31, earliest March 27, 1897 (Blackwelder); Terre Haute, Ind., average March 26, earliest March 17, 1887 (Evermann); Ottawa, Ontario, average April 30, earliest April 27, 1894 (White); Keokuk, Iowa, average April 1, earliest March 17, 1893 (Currier); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); Fort Providence, Mackenzie, May 14, 1905 (specimens in collection Biological Survey); Fort Simpson, Mackenzie, May 16, 1904 (Preble); Dawson, Yukon, May 19, 1899 (Cantwell); St. Michael, Alaska, May 24, 1879 (Nelson); Kowak River, Alaska, May 27, 1899 (Grinnell); Point Barrow, Alaska, May 30, 1883 (Murdoch), and May 30, 1898 (Stone). Eggs were secured at Cape Lisburne, Alaska, June 5, 1885 (Woolfe), and at Point Barrow, June 20–July 10, 1883 (Murdoch).

Fall migration.—In common with many other shorebirds, the pectoral sandpiper begins its fall migrations in July; indeed, it is probable that some start southward in June, for the average date of arrival on the coast of Mississippi is July 19, earliest July 15, 1903 (Allison); and at New Orleans, La., earliest July 17, 1895 (Blakemore). These birds were already more than 2,000 miles south of their breeding grounds, and had probably traveled all of this distance, for the pectoral sandpiper is not one of the species whose nonbreeders remain through the summer far south of the nesting grounds. If the fall migration was made at the same speed as the spring migration, about 35 miles per day, these July Gulf coast birds would have had to start on the return trip the middle of May, or earlier than they reach their breeding grounds. The records of this species combined with those of many others seem to indicate that the earliest fall migrants travel at a higher speed than the earliest spring migrants. This high speed in the case of the pectoral sandpiper is continued to South America and brings the first to Argentina by the end of August (Sclater and Hudson).

The regular fall migration of the young birds is a full month later, and they reach the coast of Ungava after the middle of August (Coues). Some late dates are: Northern coast of Siberia, August 20 (Pelzeln); Point Barrow, September 6, 1882 (Murdoch); St. Michael, September 6, 1899 (Osgood); Unalaska Island, October 5, 1899 (Bishop); Nushagak, Alaska, October 15, 1884 (Osgood); southern British Columbia, average October 16, latest October 25, 1905 (Brooks); Terry, Mont., October 21, 1905 (Cameron); Great Bear Lake, August 29, 1903 (Preble); Montreal, average October 25, latest November 1, 1890 (Wintle); Ottawa, Ontario, average October 29, latest November 5, 1895 (White); Lincoln, Nebr., November 4, 1899 (Wolcott); Keokuk, Iowa, November 24, 1900 (Currier); Carlisle, Pa., November 2, 1844 (Baird); Raleigh, N. C., November 15, 1894 (Brimley). A gunner near Newport, R. I., who shot 2,337 birds in 1867–1874, killed most of them between August 10 and October 10—extreme dates July 16, 1870, and October 20, 1874 (Sturtevant).

White-rumped Sandpiper. *Pisobia fuscicollis* (Vieill.).

Breeding range.—The nests and eggs of the white-rumped sandpiper have been reported from Herschell Island, Yukon (Proctor), Franklin Bay, Mackenzie, and the neighboring Barren Grounds (MacFarlane). The species was seen near Cumberland Sound July, 1878 (Kumlien), under such conditions as to make it probable that it was breeding, and is recorded as breeding at Cape Fullerton, Hudson Bay (Low). Many specimens have been taken on the west coast of Greenland from near the southern end north to Upernivik, latitude 73° (Winge), but there is no proof that any of these were breeding. At Point Barrow, Alaska, the species was noted June 6–July 6, 1883 (Murdoch), and June 2–14, 1898 (Stone), but again there is no certainty of breeding. None of the expeditions that lived and collected on Boothia Peninsula and Melville Peninsula mention this species, and it is not known to breed south of Hudson Strait. It is evident, therefore, that the thousands of individuals of this species are crowded during the breeding season into a rather narrow belt of tundra extending from near the mouth of the Mackenzie east to the southern end of Baffin Land.

Winter range.—Few species of shorebirds have so many records for Patagonia as the white-rumped, and this is also one of the species that is erroneously said to breed in the Southern Hemisphere. It winters abundantly from Paraguay and Argentina to the Falkland Islands (Sclater and Salvin) and the southern coast of Tierra del Fuego (Schalow). It is rare or casual on the coast of Chile (Gay) and unknown on the rest of the western coast of South America, except one seen at Chorillos, Peru (Taczanowski), and one taken October 12, 1864, near Huanaracama, Peru (specimen in United States National Museum).

Migration range.—During migration the white-rumped sandpiper is common along the whole eastern coast of South America, in the West Indies, and in the United States east of the Rocky Mountains. The western edge of the migration route extends from the upper Mackenzie through western Saskatchewan and eastern Colorado to the coast of southern Texas and then turns east to northern Yucatan and the island of Trinidad. The species is only an accidental visitant to Mexico (Salvin), Central America, and the whole of northwestern South America. Accidental once in California (Bryant) and several times in Europe.

Spring migration.—The species arrives in Cuba in April (Gundlach) and has been recorded in northern Yucatan April 15 (Salvin). Nearly all the dates of arrival in the United States are in May, from Florida to Maine and from Massachusetts to Colorado. The first was seen at Indian Head, Saskatchewan, May 9, 1892 (Macoun); Fort Chipewyan, Alberta, May 30, 1893 (Russell); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); Cape Fullerton, Hudson Bay, May 22, 1904 (Eifrig). There are indications that the larger number pass north in spring by way of the Mississippi Valley and return in fall along the Atlantic coast; but some individuals are found on the Atlantic coast in spring, though rare north of Virginia, and a few occur in the eastern Mississippi Valley in fall. The most surprising feature of this bird's migration is its late stay in spring south of its breeding grounds. Near Cape Horn, South America, it was abundant the winter of 1882–83 and remained until March 7, 1883 (Oustalet). It remains in southeastern Argentina until late April (Holland), and a single specimen was taken at Colonia, Uruguay, in June (Sharpe). The species remains regularly in Brazil until May (Pelzeln); one was taken on Inagua. Bahamas, May 27, 1879 (Cory); Amelia Island, Florida, May 30, 1906 (Worthington); Erie, Pa., June 4, 1875 (Sennett); Stafford County, Kans., June 6, 1907 (Peabody); Waukegan, Ill., June 9, 1876 (Nelson); Toronto, Ontario, June 21, 1898 (Nash); and at Indian Head, Saskatchewan, the last did not leave for the north until July 1, 1892 (Macoun).

Fall migration.—By early July the species is already moving south and arrived soon after July 1, 1886, at Prince of Wales Sound, Ungava (Payne), just south of the breeding grounds. During the month of July the van appears all along the New England coast, and even reaches Barbados (Feilden). August finds the species in Brazil (Pelzeln), and the collectors near Cape Horn in 1882 recorded the arrival of the first September 9 (Oustalet).

The main part reaches the northern United States in August, usually about the second week; the last leave the breeding grounds soon after the 1st of September, and the birds are seldom seen on the New England coast after the middle of October. One was taken at Ossining, N. Y., October 21, 1879 (Fisher), and a late migrant was taken at Lake Drummond, Virginia, November 5, 1898 (Fisher).

Baird Sandpiper. *Pisobia bairdi* (Coues).

Breeding range.—The Baird sandpiper has been found breeding at Point Barrow, Alaska (Murdoch), in the vicinity of Franklin Bay, Mackenzie (MacFarlane), and at Cambridge Bay, Franklin (Collinson). These localities probably represent the real extremes of the breeding range, for east or west of these limits the species is known very rarely even in migration.

Winter range.—During migration the Baird sandpiper has been noted near the summit of one of the highest mountains of Colorado at 14,000 feet (Drew). The same tendency to seek a high altitude is shown in the winter home, for this species has been taken repeatedly in the high mountains of northern Chile at 10,000 to 12,000 feet, and one specimen was secured at over 13,000 feet altitude (Sclater). Chile seems to be the principal winter home of the species, and it has been recorded here south to Talcahuano, latitude 36° 30′ S. (Sharpe). It is said to have occurred in Patagonia (Carbajal), but no definite locality is given, and in Argentina it seems not to have been recorded south of Buenos Aires (Sclater and Hudson).

Migration range.—The route the Baird sandpiper traverses between its winter and summer homes is yet to be determined. In spring migration the species is practically unknown east of the Mississippi River, and is abundant on the coast of Texas, on the plains, and in the Rocky Mountain region. Though many individuals occur in the eastern United States in fall, yet the bulk retraces its spring course and leaves the United States to the southward of the plains region. It has been noted in a few places in Mexico in fall: Colonia Garcia, Chihuahua, September 4; Chihuahua City, October 3 (Nelson); San Jose del Cabo, September 3–13 (Brewster); Janos River, Chihuahua, September 5 (Wolfe); Las Vigas, Jalapa, September (Sharpe); and Zacatecas, August 16 (Sharpe); here the record ends. The species is not recorded for Guatemala, Honduras, or Nicaragua. It is a common fall migrant in Ecuador (Salvadori and Festa), but the only records between Mexico and Ecuador are: Volcano Irazu, Costa Rica, June 8 (Cherrie); La Estrelle de Cartago, Costa Rica, November 5, 1907 (Carriker); and Medellin, Colombia (Sclater and Salvin), without date of observation.

Not many years ago the Baird sandpiper was considered merely accidental on the Atlantic coast. The past few years have witnessed a great increase of data. It is now known to be a regular and not rare migrant east to Lake Huron (Wood), Lake Erie (Todd), and the western end of Lake Ontario (Nash), and there are 50 or more printed records for the Atlantic coast region, from Four Mile Run, Va. (Matthews), north to Digby, Nova Scotia (Macoun). What becomes of these Atlantic coast birds is not yet known, for the species seems to be unrecorded in the United States south of the Ohio River and east of Mississippi, and is not known in the West Indies. It ranges regularly west to British Columbia (Brooks), but to the southward the flocks seem to pass inland west of the Sierra and are common in Nevada (Ridgway) and Arizona (Henshaw), but rare in California, where it has been taken at Point Pinos (Mailliard) and September 8, 1904, at Pacific Beach (Bishop).

Spring migration.—The Baird sandpiper is a much earlier migrant than its eastern relative, the white-rumped. It appears on the coast of Texas in early March (Brown); the average date of arrival in central Nebraska is March 24, earliest March 19, 1890 (Powell); Loveland, Colo., March 29, 1890 (Smith); southern British Columbia, April 29, 1889, and 1905 (Brooks); Indian Head, Saskatchewan, May 9, 1892 (Macoun); Fort Resolution, Mackenzie, May 19, 1860 (Kennicott); near Dyer, Alaska, May 15, 1882 (Hartlaub); Kowak River, Alaska, May 20, 1899 (Grinnell); Point Barrow, Alaska, average of three years May 29, earliest May 28, 1898 (Stone). The date of arrival at Point Barrow is worthy of notice, for at this time the birds' breeding grounds on the tundra were covered deep with snow, and it had to wait some weeks before it could begin nesting. The earliest eggs at Fort Anderson were found June 24, 1864 (MacFarlane); the next year, young were noted July 5, and downy young were taken at Point Barrow July 16, 1898 (Stone).

The species remains in Chile until the last of March (Lane), and is common in Texas to the middle of May (Lloyd). A late migrant was taken June 1, 1903, at Iguala, Guerrero (Nelson and Goldman). The last usually leave Nebraska before the first of June, but in 1900 one was seen at Lincoln on June 29 (Wolcott). The last was noted at Indian Head, Saskatchewan, June 2, 1892 (Macoun), and at Fort Chipewyan, Alberta, June 1, 1893 (Russell).

Fall migration.—Several flocks already in fall migration were seen at Great Slave Lake, Mackenzie, July 10, 1901 (Preble). Since the earliest young are not hatched until the first week in July, it is evident that these flocks of July 10, already several hundred miles south of the breeding grounds, must consist either of barren birds or of those that had suffered loss of their eggs. In southern British Columbia, the average date of arrival is August 11, earliest August 6, 1888 (Brooks); near Monterey, Calif., August 25, 1897 (Mailliard); southern Saskatchewan, July 17, 1906 (Bishop); southern Manitoba, July 23, 1881 (Macoun); Lincoln, Nebr., August 9, 1900 (Wolcott); southern Ontario, July 28, 1891 (Nash); Locust Grove, N. Y., August 18, 1885 (Henshaw); Boston Harbor, August 27, 1870 (Henshaw); Montauk, N. Y., August 14, 1907 (Braislin). In September it reaches its winter home in southern South America.

The last were seen at Point Barrow, Alaska, August 12, 1883 (Murdoch), and September 4, 1897 (Stone); southern British Columbia, September 15, 1903 (Brooks); Fort Lyon, Colo., September 28, 1885 (Thorne); Lincoln, Nebr., November 3, 1900 (Wolcott); southern Ontario, October 20, 1893 (Elliott); New Haven, Conn., October 28, 1887 (Woodruff); Galapagos Islands, October 6, 1897 (Rothschild and Hartert).

Least Sandpiper. *Pisobia minutilla* (Vieill.).

Breeding range.—The least sandpiper nests in the far north to northern Ungava (Turner); at Cambridge Bay in southern Franklin (Collinson); the coast of Mackenzie (MacFarlane); and Kotzebue Sound, Alaska (Grinnell). Unlike most of the Arctic breeding shorebirds, it breeds also quite far south to Sable Island (Oates); Magdalen Islands (Job); northeastern Quebec (Audubon); upper Hamilton River, Ungava (Low); Fort Churchill, Keewatin (Preble); Lake Marsh, southern Yukon (Bishop); and in Alaska south to Yakutat Bay (Merriam). The western limit of the breeding range in Alaska is not yet definitely settled.

Winter range.—The species is recorded without exact locality from Chile (Salvin), has been taken at several places in Peru (Taczanowski), and ranges south in Brazil to Pernambuco (Allen). Thence it is known throughout northern South America, Central America, Mexico, and the West Indies, the coast of Georgia (Helme), rarely in winter to North Carolina (Bishop), southern Texas (Merrill), southern Arizona (specimen in United States National Museum), and southern California, north at least to Owen Lake (Fisher) and Humboldt Bay (Townsend).

Migration range.—Beyond the known breeding range, the least sandpiper is found in fall on the west coast of Greenland north to Godhaven, latitude 69° (Walker); at Plover Bay, Siberia (Bean). It occurs during most if not all the summer on the Alaska Peninsula (Osgood) and on the Aleutian Islands west to Unalaska (specimen in United States National Museum).

Spring migration.—Though wintering so far north, this species is one of the later shorebirds to migrate. Most of the migrants cross the United States in early May, as shown by the following dates of arrival: Long Island, New York, average May 4, earliest April 21, 1906 (Latham); eastern Massachusetts, average May 8; city of Quebec, average May 2, earliest April 28, 1900 (Dionne); Chicago, Ill., average May 8, earliest May 4, 1898 (Gault); Oberlin, Ohio, average May 12, earliest May 8, 1905 (Jones); southern Ontario, average May 15, earliest May 8, 1889 (McIlwraith); Ottawa, Ontario, average May 18, earliest May 10, 1888 (White); Onaga, Kans., average May 11, earliest May 9, 1904 (Crevecoeur); southern Saskatchewan, average May 17, earliest May 12, 1903 (Harvey); Fort Resolution, May 19, 1860 (Kennicott); Fort Providence, May 15, 1905 (Mills); Fort Simpson, May 17, 1904 (Preble); Loveland, Colo., average April 21, earliest April 19, 1890 (Smith); Cheyenne, Wyo., average April 28, earliest April 23 1888 (Bond); Newport, Oreg., average April 29, earliest April 21, 1901 (Bretherton); southern British Columbia, average April 22, earliest April 20, 1905 (Brooks); Nulato, Alaska, May 11, 1867 (Dall); Kowak River, Alaska, May 15, 1899 (Grinnell).

Eggs were taken near Fort Anderson, Mackenzie, June 21, 1862; June 24, 1863, and June 30, 1864 (MacFarlane); Yakutat Bay, Alaska, June 21, 1899 (Merriam); downy young at Lake Marsh, Yukon, July 2, 1899 (Bishop), and an egg ready to lay at the Kowak River, Alaska, June 1, 1899 (Grinnell).

Fall migration.—The following dates of arrival show how very early some individuals of the species must start southward: Sitka, Alaska, common July 2, 1896 (Grinnell); southern British Columbia, July 2, 1889 (Brooks); North Dalles, Wash., July 4, 1897 (Fisher); near San Diego, Calif., July 13, 1894 (Mearns); Fort Bridger, Wyo., July 13, 1858 (Drexler); Lincoln, Nebr., July 14, 1900 (Wolcott); Detroit, Mich., July 9, 1905 (Swales), July 7, 1906 (Taverner); near Toronto, Ontario, July 4, 1891 (Nash); Lexington, Ky., July 16, 1905 (Dean); Long Island, New York, average July 8, earliest July 6, 1898 (Worthington); Bahamas, July 16, 1903 (Riley), July 18, 1904 (Allen); the Lesser Antilles, the middle of July (Feilden); off the coast of Venezuela, July 23, 1892 (Hartert).

Some dates of the last seen are: Cape Blossom, Alaska, August 10, 1898 (Grinnell); southern British Columbia, average September 11, latest September 18, 1903 (Brooks); Aweme, Manitoba, average September 4, latest September 26, 1899 (Criddle); Long Island, New York, September 17, 1905 (Latham); Erie, Pa., October 3, 1895 (Todd); Back River, Maryland, November 3, 1894 (Kirkwood).

Long-toed Stint. *Pisobia damacensis* (Horsf.).

The long-toed stint is a species of eastern Asia, accidental in North America. It breeds in eastern Siberia, Kamchatka, Bering Island, and south to the Kurile Islands; west probably to the valley of the Lena River. This statement of breeding range is based on the occurrence of the species in summer, since the nest and eggs are still unknown. The species passes south for the winter, through China and Japan, to Australia, the Malay Archipelago, Burma, and India. The only record in North America is of a single specimen taken June 8, 1885, on Otter Island, Alaska (Ridgway).

[**Cooper Sandpiper.** *Pisobia cooperi* (Baird).

The Cooper sandpiper is known only from the single specimen now in the National Museum, taken in May, 1833, on Long Island. The status of the species is still in doubt.]

Dunlin. *Pelidna alpina* (Linn.).

The dunlin, an Old World species, has been noted a few times in North America. A specimen was taken October 20, 1842, at Washington, D. C., and two days later a second was secured (Smith); one was captured September 15, 1892, at Shinnecock Bay, Long Island, New York (Young), and one August 11, 1900, at Chatham, Mass. (Howe and Allen). There are less certain records of its occurrence in the region of Hudson Bay (Blakiston). There seems to be no sure record for Greenland, though the regular breeding range extends west to England, Scotland, and Iceland. The species breeds east to Turkestan and probably to the valley of the Yenisei, and north to the islands of the Arctic coast. It winters from Great Britain and the Caspian Sea south to northern Africa and India.

Red-backed Sandpiper. *Pelidna alpina sakalina* (Vieill.).

Breeding range.—The red-backed sandpiper has two well-defined breeding areas corresponding in general to the Atlantic and Pacific winter ranges. The birds of the Atlantic coast breed from northeastern Ungava (Weiz) and Cape Fullerton, Hudson Bay (Low), north to Bellot Strait (McClintock). A few (of either this form or the last) breed on the west coast of Greenland, from which country there are eggs in the United States National Museum. The birds of the Pacific coast breed in Alaska from the mouth of the Yukon (Nelson) north to Point Barrow (Murdoch), and on much of the northern coast of Siberia west possibly to Yenisei River (Seebohm). The region of intergradation along the coast of Siberia is not yet definitely determined. These two breeding areas are separated by nearly 1,500 miles of Arctic coast, from Point Barrow to the Boothia Peninsula, and throughout this whole region there seems to be no certain record of the occurrence of the red-backed sandpiper. If it does occur, it must be very rare, and the probability that it does not is increased by the fact that the species is not known as a migrant in the region immediately to the south. It is abundant as a migrant along the west coast of Hudson Bay (Preble) and has been taken at Dawson, Yukon (Cantwell), but as yet is unrecorded in the intervening districts.

Winter range.—Few of the shorebirds go so short a distance to the southward as the red-backed sandpiper. It is common in winter as far south as central Florida (Scott), and has been recorded once in the Bahamas (Todd). On the coast of Texas it ranges to the mouth of the Rio Grande (Merrill), but is not yet known in northeastern Mexico. On the Pacific coast it is abundant south to southern Lower California (Belding), but seems not to pass farther south. The only record south of the region just outlined is that of a specimen, undoubtedly a straggler, taken May 23, at Momotomba, Nicaragua (specimen in British Museum). During the winter the species remains north to the coasts of North Carolina (Bishop), New Jersey, casually (Stone), Louisiana (Beyer), Texas (Carroll), and at least to central Washington (Bowles). The Siberian birds of this form winter from Japan and China to the Malay Archipelago.

Spring migration.—Most of the spring movements occur in May, but a few early birds press northward in April: Long Beach, New Jersey, April 17, 1877 (Scott); Long Island, New York, April 3, 1882 (Chapman); Erie, Pa., April 21, 1900 (Todd). On the Atlantic coast north of Massachusetts the species is not so common in spring as in fall, while around the Great Lakes the reverse is the case. The main body of the Atlantic coast birds seem to reach their breeding grounds by way of the Great Lakes and Hudson Bay. Along this route they are late migrants, reaching southern Ontario on the average May 20, earliest May 13, 1905 (Taverner).

The Pacific coast birds appeared in southern British Columbia April 25, 1888 (Brooks), and April 26, 1889 (Brooks); one was seen as early as April 2, 1897, at Howcan (Cantwell), in the extreme southern part of Alaska. Other dates of spring arrival are: Fort Kenai, May 16, 1869 (Osgood); Kigulik Mountains, May 17, 1905 (Anthony); Dawson, Yukon, May 24, 1899 (Cantwell); Point Barrow, Alaska, May 31, 1882 (Murdoch), May 29, 1883 (Murdoch), and June 2, 1898 (Stone).

None were noted in Lower California after May 10 (Belding), but in central Florida they have been recorded as late as June 2, 1886 (Scott), and in southern Ontario the average date of the last seen is June 4, latest June 13, 1891 (Nash).

Eggs have been taken at the mouth of the Yukon, June 6, 1879 (Nelson); Cape Prince of Wales, June 27, 1898 (Grinnell); and at Point Barrow, June 22, 1883 (Murdoch). At this last locality the eggs in some seasons must be laid earlier than the above date, for in 1898 downy young were taken July 6 (Stone).

Fall migration.—Early fall migrants were passing south July 19, 1900, along the west shore of Hudson Bay, near York Factory (Preble), and two weeks later they were enormously abundant, showing that this is one of the principal routes in fall migration. Since the species is not common in the Mississippi Valley and is comparatively rare in western Ontario in the fall, it is evident that many of these Hudson

Bay birds turn eastward to the Atlantic coast. An early arrival appeared on Long Island, New York, July 17, 1897 (Worthington), but the usual time of arrival is a month or more later; Hayward, Calif., August 3, 1889 (Emerson); Point de Monts, Quebec, August 28, 1883 (Merriam); Plymouth, Mass., September 17, 1852 (Browne); Erie, Pa., September 21, 1875 (Sennett); Washington, D. C., September 25, 1894 (Hasbrouck).

The last deserted the breeding grounds at Point Barrow, Alaska, September 7, 1882 (Murdoch); September 4, 1897 (Stone). The last have been noted at St. George Island, Alaska, October 3, 1899 (Bishop); Bering Island, October 25, 1884 (Grebnitsky); Chicago, Ill., November 3, 1906 (Ferry); Oberlin, Ohio, October 27, 1906 (Jones); St. Clair Flats, Michigan, November 20, 1904 (Blain); Ottawa, Ontario, average October 4, latest October 29, 1889 (White); Portland, Me., November 11, 1906 (Eastman); Barnstable, Mass., December 23, 1903 (Howe); Comox, British Columbia, December 5, 1903 (Brooks).

Curlew Sandpiper. *Erolia ferruginea* (Brünn.).

The curlew sandpiper breeds only in the Eastern Hemisphere, but wanders not infrequently to the Atlantic coast of North America. The only eggs so far known were taken July 3, 1897, in the delta of the Yenisei River, Siberia (Newton), and June 24–July 6, 1900, on the northwestern coast of the Taimyr Peninsula, Siberia (Dresser). It is probable that all Greenland records for this species are erroneous, and that the only reliable record in Arctic America is that of the single individual taken June 8, 1883, at Point Barrow, Alaska (Murdoch). On the Atlantic coast of America it has been recorded about twenty times from Halifax, Nova Scotia (Jones), to Cape May, N. J. (Abbott). A few dates are in May, but the larger part are in the fall from August to October. One specimen was taken about 1886 in the interior at Toronto, Ont. (Fleming). The species has been recorded from Grenada Island, West Indies (Cory), and there is a specimen in the British Museum said to have been taken in eastern Patagonia.

In winter the curlew sandpiper ranges south to southern Africa, India, the Malay Archipelago, and Australia. During migration it has been noted in the Philippines and China, and west to Great Britain.

Spoon-bill Sandpiper. *Eurynorhynchus pygmeus* (Linn.).

The spoon-bill sandpiper inhabits the Eastern Hemisphere and ranges in summer to northeastern Siberia. It migrates through Japan and China and winters as far south as Burma and India. One was taken in 1849 on the Choris Peninsula of Alaska—the only record for the Western Hemisphere.

Semipalmated Sandpiper. *Ereunetes pusillus* (Linn.).

Breeding range.—The semipalmated sandpiper breeds in Ungava at Okak (Crandall) and south to Fort George (Drexler), and also on the Barren Grounds from Hudson Bay (Eifrig) west to Franklin Bay (MacFarlane), along the Arctic coast to Kotzebue Sound, Alaska (Grinnell), and south on the western coast of Alaska to St. Michael (specimens in United States National Museum).

Winter range.—It winters mainly in eastern South America, south to Patagonia (latitude 43° S.) (Seebohm), and thence north through Central America and the West Indies to eastern Mexico (Sumichrast), southern Texas (Refugio County; Carroll), Florida (Scott), and the coast of Georgia (Helme) and South Carolina (specimen in United States National Museum).

Migration range.—The semipalmated sandpiper is a rare spring but an abundant fall migrant along the whole Atlantic coast. It is a common fall migrant through the Bermudas (Hurdis), Bahamas (Bryant), and the West Indies east of Cuba. It is common both spring and fall in the Mississippi Valley, becoming less common westward to the eastern base of the Rocky Mountains, and west of the mountains to western British Columbia (Brooks), Sitka, Alaska (Bischoff), Cook Inlet (Chapman), Norton Sound (McGregor), St. Paul Island (Palmer), and the coast of northeastern Siberia (Nelson). It has occurred in migration on the coast of Peru (Salvin).

Spring migration.—Almost all the spring records for the Atlantic coast are in May, while migration in the Mississippi Valley begins in April: Camden, Ind., average of three years April 21, earliest April 18, 1886 (Groninger); Keokuk, Iowa, average of eight years April 30, earliest April 19, 1898 (Currier); Fort Lyon, Colo., April 25, 1886 (Thorne); Indian Head, Saskatchewan, May 16, 1892 (Macoun); Fort Chipewyan, Alberta, May 24, 1901 (Preble); Great Bear Lake, Mackenzie, May 24, 1826 (Richardson); Kowak River, Alaska, May 29, 1899 (Grinnell). Nonbreeding birds are found here and there in summer from Wisconsin (Kumlien and Hollister) to Massachusetts (Howe and Allen).

Eggs have been taken at Fort George, Ungava, June 24, 1860 (Drexler); Franklin Bay, Mackenzie, June 30, 1864 (young July 5, 1865), (MacFarlane); St. Michael, Alaska, June 9, 1880 (specimens in United States National Museum); and young just hatched at Cape Blossom, Alaska, June 30, 1898 (Grinnell).

Fall migration.—Like so many other sandpipers the semipalmated begins to move south so early that it appears in the United States in July; southern Mississippi, average of three years July 16, earliest July 10, 1905 (Brodie and Kopman); Fernandina, Fla., July 14, 1906 (Worthington); Porto Rico, August 11, 1901 (Bowdish); La Guaira, Venezuela, August 10 (Robinson and Richmond), and Marajo, Brazil, August 4 (Allen). Specimens were taken July 3, 1907, at Coronado de Terraba, Costa Rica (Carriker), but these may have been nonbreeders that had not made the northward journey. Young birds migrate about a month later, and it is probably these that afford the following average dates: North River, Prince Edward Island, August 8 (Bain); Long Island, New York, August 10 (Worthington); Beaver Pa., August 14 (Todd); Keokuk, Iowa, August 18 (Currier).

The average date of the last one seen at Point Barrow, Alaska, is August 15, latest August 18, 1882 (Murdoch); Herschel Island, Yukon, August 2, 1894 (Russell); York Factory, Keewatin, August 26, 1900 (Preble); Ottawa, average of the last one seen September 9, latest September 17, 1892 (White); Lewiston, Me., October 17, 1900 (Johnson); Ossining, N. Y., October 20, 1885 (Fisher); Washington, D. C., October 26, 1887 (Richmond).

Western Sandpiper. *Ereunetes mauri* Cabanis.

Breeding range.—The western sandpiper's breeding range, as at present known, is a narrow strip along the northwestern coast of Alaska from the mouth of the Yukon (specimens in United States National Museum) to Cape Prince of Wales (Grinnell).

Winter range.—Though breeding only on the northwest coast, this sandpiper is common in winter on the Atlantic coast from North Carolina (Bishop) to Florida (Scott). This long migration across the continent to the southeastward from the breeding grounds is very remarkable, and is not paralleled in the case of any other shorebird. It is, however, comparable with the migration of several species of ducks from the Mackenzie Valley to Chesapeake Bay. The species also winters from La Paz, Lower California (specimen in National Museum), to southern Mexico (Lawrence), Guatemala (Sharpe), Colombia (Ridgway), and Venezuela (Robinson), and undoubtedly to the Lesser Antilles, but its distribution in the West Indies is not yet known with any accuracy.

Migration range.—In passing from the summer to the winter home, the western sandpiper comes east to the Atlantic coast at least as far north as Massachusetts (Henshaw), and sometimes is quite common in the fall on Long Island (Braislin) and the coast of New Jersey (Baily). The strange fact is that there are no corresponding records from the interior to indicate the route by which these birds reach New England. The species seems not to be known north of southern Wisconsin (Kumlien and Hollister), Colorado (Osburn), and southern Wyoming (specimen in National Museum), while in all of the Mississippi Valley between the river and the Rocky Mountains the species is so very rare as to make it improbable that any large part of the New England birds migrate through this section. In fall migration the species is known west in the Aleutians to Unalaska Island (Palmer).

Spring migration.—Along the Atlantic coast the species is almost unknown in spring north of its winter range; the few known occurrences are in May. To the westward some dates of spring arrival are: Galveston, Tex., March 24, 1891 (Singley); San Pedro River, Arizona, April 17, 1902 (Howard); Monterey, Calif., April 6, 1903 (Brenninger); Redwood City, Calif., April 14, 1907 (Carriger and Pemberton); Corvallis, Oreg., April 21, 1899 (Woodcock); southern British Columbia, April 26, 1889, and April 20, 1905 (Brooks); Fort Kenai, Alaska, May 12, 1869 (Bischoff); St. Michael, May 28, 1874 (Turner).

Most of the individuals have left southern Lower California by May 10 (Belding) and the northern part by the middle of the month (Kaeding). The species was still present at Owen Lake, California, June 1, 1891 (Fisher). Eggs have been found at the mouth of the Yukon June 5 (specimens in United States National Museum) and near Cape Prince of Wales, June 28, 1898 (Grinnell).

Fall migration.—The first fall migrants were noted at Tulare Lake, California, July 7–8, 1907 (Goldman), and the species was taken off the coast of Venezuela July 7, 1895 (Robinson). The first of these records probably represents birds in migration; the other, nonbreeders that had summered far south of the breeding grounds. Some other fall records are: Southern British Columbia, average of five years August 14 as the date of fall arrival (Brooks); Semiahmoo Bay, Washington, July 15, 1857 (Kennerly); Santa Barbara, Calif., July 3, 1875 (Sharpe); Fort Bridger, Wyo., July 13, 1858, (Drexler); near Arco, Idaho, July 25, 1890 (Merriam); Rockport, Tex., August 12, 1905 (Howell); Monomoy Island, Massachusetts, July ·19, 1888 (Brewster); Charleston, S. C., about July 8 (Wayne); Haiti, July 11, 1883 (Stone); San Mateo, Tehuantepec, August 7, 1869 (specimen in United States National Museum). The latest date in southern British Columbia is September 11, 1889 (Brooks); Hayward, Calif., November 4, 1889 (Emerson); Monomoy Island, Massachusetts, September 19, 1888 (Brewster); Cape May County, N. J., September 15, 1895 (Baily); Washington, D. C., September 22, 1894 (Hasbrouck).

Sanderling. *Calidris leucophæa* (Pallas).

Breeding range.—The sanderling is a cosmopolite, breeding and wintering in both hemispheres. It is known to breed north to Point Barrow, Alaska (Stone), Melville Island (Fisher), Grinnell Land (Feilden), both coasts of Greenland (Bessels and Winge), the Taimyr Peninsula, Siberia (Walter), and undoubtedly breeds on the New Siberian Islands (Newcombe). It breeds south to Iceland (Oates), to Cape Fullerton, Hudson Bay (Low), and to Franklin Bay, Mackenzie (MacFarlane).

Winter range.—Some sanderlings pass in winter to central Argentina (Tambo Point, 44° S.: Durnford), and to Talcahuano, central Chile (Sharpe), 8,000 miles from the nearest breeding grounds; while others remain as common winter residents on the Atlantic coast of the southeastern United States north to North Carolina (Smithwick) and casually even to Massachusetts (Mackay). The species winters on the coast of Texas (Merrill) and on the Pacific coast regularly to central California (Cooper) and occasionally to Washington (Cooper and Suckley).

It occurs in fall migration on the Hawaiian Islands, where it has been taken from September 25 to October 14 and where a few may winter (Henshaw).

The sanderlings of the eastern hemisphere winter from the Mediterranean and Japan south to southern Africa, the Malay Archipelago, and Oceania.

Migration range.—The sanderling is common on the coasts of the world and on the larger inland waters. It is abundant on both coasts of North America and common on the Great Lakes. It has been recorded in migration from almost every State of the Union, but is quite rare in all the district between the Great Lakes and the Pacific coast.

Spring migration.—The northward movement begins in March, bringing the species the latter part of this month to the New England coast and to the central Mississippi Valley. Further advance is so slow that the sanderling is among the later birds to arrive at the breeding grounds, which are reached the first week in June. Some dates of spring arrival are: Fort Simpson, Mackenzie, May 29, 1904 (Preble); Point Barrow, Alaska, latitude 71°, June 2, 1882 (Murdoch), June 6, 1898 (Stone); Prince of Wales Strait, 73°, June 7, 1851 (Armstrong); Bay of Mercy, 74°, June 3, 1852 (Armstrong); Winter Island, 66°, June 10, 1822 (Lyon); Igloolik, 69°, June 16, 1823 (Parry); Grinnell Land, 82° 33′, June 4, 1876 (Feilden); west coast of Greenland at 72°, May 29, 1850 (Sutherland); at 78°, June 5, 1854 (Kane); Taimyr Peninsula, Siberia, 74°, June 4 (Seebohm). Specimens were taken in Chile in May (Schalow); in British Honduras May 18–20 (Salvin); southern Florida, May 25 (Scott); the coast of New Jersey, June 13 (Abbott). The species remains regularly on the New England coast and about the Great Lakes until the first week in June. The fact that nonbreeders remain through the summer far south of the nesting grounds has probably furnished the basis for the reports of the breeding of the species south of the Arctic coast.

The first eggs known to science were taken June 29, 1863, near Franklin Bay, Mackenzie (MacFarlane), a locality where the species is very rare. The most northern known eggs were taken June 24, 1876, near the north coast of Grinnell Land, at latitude 82° 33′ (Feilden). Eggs were taken in July at Thank God Harbor, Greenland (Bessels), and both late June and early July on the Taimyr Peninsula, Siberia (Walter).

Fall migration.—The sanderling was seen off the coast of Venezuela July 7, 1895 (Robinson), but regular fall migration does not begin until some weeks later, as shown by the following dates of fall arrival, which in each case are considerably earlier than the average: Big Stick Lake, Saskatchewan, July 19, 1906 (Bent); Lincoln, Nebr., August 7, 1900 (Wolcott); Toronto, Ontario, July 16, 1898 (Nash); Newfoundland, August 2, 1887 (Palmer); Erie, Pa., July 27, 1900 (Todd); Long Island, New York, July 20, 1900 (Scott); San Mateo, Tehuantepec, August 5, 1869 (Sumichrast). The last was seen at Point Barrow, August 27, 1897 (Stone); St. Michael, Alaska, September 11, 1899 (Bishop); Homer, Alaska, August 29, 1901 (Chapman); Prince of Wales Strait, August 30, 1850 (Armstrong); Grinnell Land, about August 31, 1882 (Greely); Prince Edward Island, October 30, 1887 (Bain); Montreal, Canada, October 7, 1889 (Wintle); Lincoln, Nebr., October 4, 1898 (Bruner, Wolcott, and Swenk); Ottawa, Ontario, October 22, 1887 (White); Erie, Pa., November 17, 1902 (Todd).

Marbled Godwit. *Limosa fedoa* (Linn.).

Breeding range.—Formerly the marbled godwit was a common breeder in northern Nebraska (Say), in northern Iowa south to about latitude 43° (Preston), and a few undoubtedly nested in Wisconsin, at about the same latitude (Kumlien and Hollister). It is not probable that the species now breeds in either State, and the principal summer home at the present time is from northern North Dakota (Rolfe) to the valley of the Saskatchewan (Bent).

Winter range.—The species passes south in winter to southern Guatemala (Salvin) and Belize (Sclater and Salvin), and remains as far north as southern Lower California (Forrer) and the coasts of Louisiana (Beyer), Florida (Scott), and Georgia (Worthington).

Migration range.—On the way from the summer home to the winter, some individuals formerly took a course almost due east and appeared in the Maritime Provinces of Canada (Macoun) and on the coast of New England (Brown), becoming more common to the south until it would hardly have been called rare on Long Island and the New Jersey coast. At the present time it is almost unknown on the Atlantic coast north of Florida. There seem to be no winter records of the species in the West Indies, but as a rare visitant in fall migration it has been recorded from Cuba (Gundlach), Porto Rico (Gundlach), Grenada (Wells), Carriacou (Wells), and Trinidad islands (Leotaud).

A migration also takes place westward to the Pacific coast. Though the species is not known to breed within several hundred miles of the Rocky Mountains, yet it has been noted on the coast of southern Alaska (Osgood) nearly a thousand miles west of the nearest breeding grounds. This species therefore presents the unique spectacle of a bird breeding in the middle of the American continent and migrating directly east and directly west to the ocean coasts. A wanderer was taken at Point Barrow, Alaska, August 26, 1897 (Stone), and several specimens have been taken on Hudson Bay (Preble). Individuals probably sometimes winter in California, as one was taken at Humboldt Bay, December 7, 1885 (Townsend), and at Lake Elsinore, February, 1902 (Nordhoff).

Spring migration.—The marbled godwit is among the earlier migrants of the shorebirds; it reaches central Illinois in early April (Griffin); Heron Lake, Minnesota, average April 12, earliest April 8, 1889 (Miller); Lincoln, Nebr., April 18, 1899 (Wolcott); Loveland, Colo., average April 27, earliest April 20, 1887 (Smith); Shoalwater Bay, Washington, April 13, 1854 (Cooper); southern Manitoba, average May 1, earliest April 29, 1901 (Wemyss); southern Saskatchewan, average May 3, earliest April 16, 1907 (Lang). Nearly all of the few spring records on the Atlantic coast are in May.

Eggs have been found at Oakland Valley, Iowa, April 20, 1878 (Rice); Winnebago, Iowa, May 6, 1871 (Krider); Miner County, S. Dak., May 16, 1892 (Patton); Minnewaukan, N. Dak., May 22, 1892 (Rolfe); in Grant County, Minn., May 24, 1876 (Sennett); and in southern Saskatchewan, May 29, 1905 (Bent). The birds and their young were common June 8, 1820, near the mouth of the Loup Fork of the Platte, Nebraska (Say).

Fall migration.—The return movement begins in July, since migrants have been taken at Ugashik, Alaska, July 16, 1881 (Osgood), on the New Jersey coast late in the month (Stone), and on Pea and Bodie islands, North Carolina, July 11, 1904 (Bishop). A gunner who shot for the market near Newport, R. I., obtained only 26 of these godwits during eight seasons, the extreme dates ranging from August 6, 1873, to October 2, 1868 (Sturtevant). The latest date in Colorado is October 1, 1874 (Henshaw).

Pacific Godwit. *Limosa lapponica baueri* Naum.

The principal breeding range of the Pacific godwit is in northeastern Siberia, but a few individuals cross to Alaska and breed from Unalaska (Dall) to Kotzebue Sound (Grinnell). After the breeding season some wander northward to Point Barrow (Murdoch). They arrive on their breeding grounds early in May (Nelson), and are among the earliest of the waders to begin the fall migration (Nelson). The latest one seen at Point Barrow was August 18 (Murdoch), and early in September the last have left North America. The migration route passes through the Pribilof Islands, Commander Islands, Japan, China, and the Philippines. The winter home is in Australia, New Zealand, the Malay Archipelago, and many of the islands of Oceania. The Pacific godwit has been noted several times in the Hawaiian Islands (Bryan), and a straggler was once taken at La Paz, Lower California (Belding).

Hudsonian Godwit. *Limosa hæmastica* (Linn.).

Breeding range.—The eggs of the Hudsonian godwit are known only from the Anderson River region of northwestern Mackenzie (MacFarlane), but since Edward A. Preble, of the Biological Survey, found the species common in July and August on the west coast of Hudson Bay, probably it breeds also not far north of this region. The breeding range is probably the Barren Grounds from the mouth of the Mackenzie to Hudson Bay.

Winter range.—The species winters in Argentina and Chile south to Chiloe Island (Sclater and Salvin) on the west coast and to the Strait of Magellan (Sharpe) and the Falkland Islands (Abbott). But it is rare in eastern Patagonia south of the Chubut River (Durnford), which is just opposite the southern limit on the western coast.

Migration range.—The migration route between the winter and summer homes is not known. In fall migration the species appears rarely on the coast of Maine (Boardman) and more commonly in Massachusetts (Howe and Allen), Rhode Island (Sturtevant), and Long Island (Dutcher). Whither the birds go when they leave Long Island is as yet unknown. On the rest of the coast of the United States the species is known only as a very rare straggler. One accidental occurrence in Cuba (Gundlach) is the only record for the Greater Antilles, and in the Lesser Antilles it is known only from the extreme eastern end on Barbados (Feilden) and Trinidad (Leotaud). It occurs on the coast of British Guiana (Quelch) and in the interior of Brazil (Pelzeln).

The species seems not to be recorded in spring anywhere on the Atlantic coast between Argentina and Long Island, with the exception of a single pair seen May 8, 1906, near Rehoboth, Del. (Pennock). The very few records on Long Island (Sharpe) and in New England (Howe and Allen) during the spring indicate that at this season it is only a straggler along the Atlantic. It passes in spring migration up the Mississippi Valley, entering the United States through Louisiana (Beyer) and Texas (Sharpe) and passing north principally along the eastern edge of the plains. The migration route between Argentina and Texas is unknown, for there is not a single spring record in the whole distance, and records at any time in the year are limited to one on the coast of Peru, November 9, 1883 (MacFarlane); one in Cuba, no date specified (Gundlach); and very doubtful records for Colombia (Burger) and Costa Rica (Zeledon).

From the above very meager data, it seems probable that the Hudsonian godwit has a migration route similar to that of the golden plover, with this important difference—that whereas the golden plover first goes eastward from its breeding grounds to the coast of Labrador and crossing the Gulf of St. Lawrence strikes out to sea from Nova Scotia, the Hudsonian godwit starts in a south-easterly course to and down the western shore of Hudson Bay and keeps much this same course overland to the coast of New England. Thence it goes directly across the ocean to the Lesser Antilles and British Guiana, and lastly south and southwest through central Brazil to the pampas of Argentina, and to the coast of central Chile. Judging by analogy from the golden plover, the spring migration route of the Hudsonian godwit is from the pampas of northwestern Argentina directly to the coast of Texas, and almost in one flight.

This species is rare west of the Rocky Mountains. The British Museum contains specimens said to have been taken in California (Sharpe), but as this is the only record for the State it needs confirmation. A few specimens have been taken in Alaska from the Kenai Peninsula (Osgood) to the Yukon mouth (Dall and Bannister), Nulato (Sharpe), and Point Barrow (Stone) on the north, but there is no evidence that the species breeds west of the Mackenzie River. Though the Hudsonian godwit is now very rare on the New England coast, and has been since about 1886, yet previously it was so common that a gunner near Newport, R. I., records the shooting of 104 birds in the years 1867–1874 (Sturtevant).

Spring migration.—The species arrives on the coast of Texas in April (Sharpe) and has been recorded at Lawrence, Kans., as early as April 19, 1873 (Snow); St. Louis, Mo., April 19, 1872 (Hurter); in Grant County, Minn., April 25, 1876 (Sennett); Indian Head, Saskatchewan, May 11, 1892 (Macoun); Fort Kenai, Alaska, May 5, 1869 (Bischoff). Specimens were taken on the Falkland Islands as late as May 20, 1860 (Abbott), and in Argentina to May 24 (Sharpe). The earliest eggs taken were on June 7, 1862, at Fort Anderson (MacFarlane).

Fall migration.—A Biological Survey party found the Hudsonian godwit already in southward migration July 19, 1900, near York Factory, Keewatin (Preble); it was noted July 29, 1869, on the coast of Rhode Island (Sturtevant); it arrives in August in the Lesser Antilles (Leotaud); in September in Brazil (Pelzeln); and by early November has appeared at the extreme southern limit of the range (Durnford). It is probably the arrival of young birds that is recorded at Barbados (Feilden) in October, with October 7 as the average of three years and October 5, 1886, as the earliest.

The last seen near Cape Churchill, Hudson Bay, in 1900, was on August 24 (Preble); Toronto, Ontario, October 20, 1890 (Fleming); Montreal, Canada, October 11, 1895 (Wintle); Rhode Island, October 13, 1873 (Sturtevant), and Massachusetts, November 3 (Howe and Allen).

Black-tailed Godwit. *Limosa limosa* (Linn.).

The black-tailed godwit is confined to the Eastern Hemisphere, breeding in Iceland, and from Holland and southern Russia north to the Arctic Circle and east to western Siberia. It winters in southern

Europe and south to Abyssinia. A specimen was taken about 1830 near Godthaab, Greenland (Reinhard), and there are other less certain records of its occurrence in that country.

Green-shank. *Glottis nebularia* (Gunn.).

The green-shank has a very wide range in the Eastern Hemisphere. It breeds in Scotland, northern Scandinavia, and east to northern Siberia; it migrates along the coasts of both Europe and Asia, even to Japan and the Commander Islands; it winters from southern Europe and India to southern Africa and Australia.

The only record for the United States is that of three specimens taken by Audubon, May 28, 1832, on Sand Key, near Cape Sable, Florida. The species has also been recorded as an accidental visitant to Chile (Schlegel) and Buenos Aires, Argentina (Seebohm).

Common Red-shank. *Totanus totanus* (Linn.).

The common red-shank is scarcely entitled to a place among North American birds. Its claim rests only on the description by Swainson and Richardson of a specimen from Hudson Bay which they said existed in the British Museum.

The common red-shank is a well-known species of Europe and Asia, where it breeds from Iceland and the Faroe Islands to southern Siberia and Turkestan and south to northern Africa. It winters in southern Europe, throughout most of Africa, and in Asia south to India and the Malay Archipelago.

Greater Yellow-legs. *Totanus melanoleucus* (Gmel.).

Breeding range.—Knowledge of the summer home of the greater yellow-legs is much lacking in definiteness. One of the best known facts is that the bird does not go far north, since it is one of the few species of the family not found on the Arctic coast, nor even to the Arctic Circle. The most northern records are: Near Fort Chimo, Ungava (Turner); accidental once at Cumberland Sound (Kumlien); on the west shore of Hudson Bay to about Cape Eskimo (Preble); Fort Simpson, Mackenzie (Ross); and to Kupreanof Island (Osgood), Lake Iliamna (Osgood), and St. Paul Island (Seale)—all in Alaska. The southern limit of the breeding range is more difficult to determine, since the mere presence of the bird in summer is not sufficient proof that it is breeding. Individuals are found during every month of the year in the West Indies, Bahamas, Florida, Texas (Sennett), and California (Grinnell), but it is not probable that the species breeds in any of these localities.

Eggs have been taken in British Columbia at Fort George and Fort St. James (specimens in United States National Museum), and three sets on June 3 and June 13, 1911, in Newfoundland (Arnold). The bird probably breeds in British Columbia as far south as Clinton (Rhoads), and eastward across Canada, north of about the fiftieth parallel of latitude.

Winter range.—The greater yellow-legs winters to the southern end of the mainland of South America. To the north it occurs on both coasts and in Central America, Mexico, and the West Indies to the coast of

Georgia (Helme)—occasionally to North Carolina (Bishop)—Louisiana (Edwards), Texas (Merrill), and California. In this latter State it winters on the coast north at least to Los Angeles County (Grinnell), and in the interior to Owen Lake (Fisher).

Spring migration.—The advance begins in March, and the first reach Raleigh, N. C., on the average April 3, earliest March 22, 1893 (Brimley); Long Island, New York, average April 22, earliest April 17, 1896 (Worthington); eastern Massachusetts, average April 26, earliest April 22, 1893 (Browne); southern Maine, average May 9, earliest April 26, 1896 (Morrell); city of Quebec, Canada, average April 30, earliest April 18, 1903 (Dionne); Point de Monts, Quebec, average May 5, earliest April 26, 1885 (Comeau). Lake Mistassini, Quebec, May 7, 1885 (Macoun). Some other early dates along the Atlantic coast are: Patapsco Marsh, Maryland, March 26, 1875 (Kirkwood); Carlisle, Pa., March 19, 1844 (Baird); Westport Harbor, Massachusetts, March 10, 1899 (Howe and Sturtevant). The average date of arrival in central Illinois is April 6, earliest March 22, 1890 (Brown); Chicago, Ill., average April 24, earliest April 14, 1895 (Blackwelder); Oberlin, Ohio, average April 18, earliest April 12, 1905 (Jones); southern Michigan, average April 27, earliest April 24, 1897 (Hankinson); southern Ontario, average April 28, earliest April 13, 1896 (Taverner); Ottawa, Ontario, average May 9, earliest April 28, 1905 (White); Keokuk, Iowa, average April 14, earliest March 26, 1893 (Currier); Elk River, Minn., average April 21, earliest April 17, 1886 (Bailey); Aweme, Manitoba, average May 4, earliest April 30, 1902 (Criddle); Kansas City, Mo., March 9, 1903 (Bryant); Manhattan, Kans., March 11, 1883 (Lantz); Lincoln, Nebr., April 10, 1899 (Wolcott); Fort Lyon, Colo., March 28, 1886 (Thorne); Loveland, Colo., March 26, 1890 (Smith); Cheyenne, Wyo., April 11, 1888 (Bond); Great Falls, Mont., April 17, 1892 (Williams); Rathdrum, Idaho, April 20, 1901 (Danby); Fort Simpson, Mackenzie, May 23, 1860 (Ross), May 16, 1904 (Preble); Chilliwack, British Columbia, March 28, 1888 and 1889 (Brooks); Fort Kenai, Alaska, May 6, 1869 (Bischoff).

Those individuals that are to breed leave the United States by the first week in June. The species is common in Chile and Argentina through the winter and to early April, when most leave for the north, but some remain the whole summer in Argentina (Holland), 6,000 miles south of the breeding range.

Eggs have been taken at Fort St. James, British Columbia, May 31, 1889 (MacFarlane), and at Fort George, British Columbia, May 20, 1890 (specimens in United States National Museum). The earliest downy young noted in 1901 in the Caribou district, British Columbia, were seen on June 15 (Brooks).

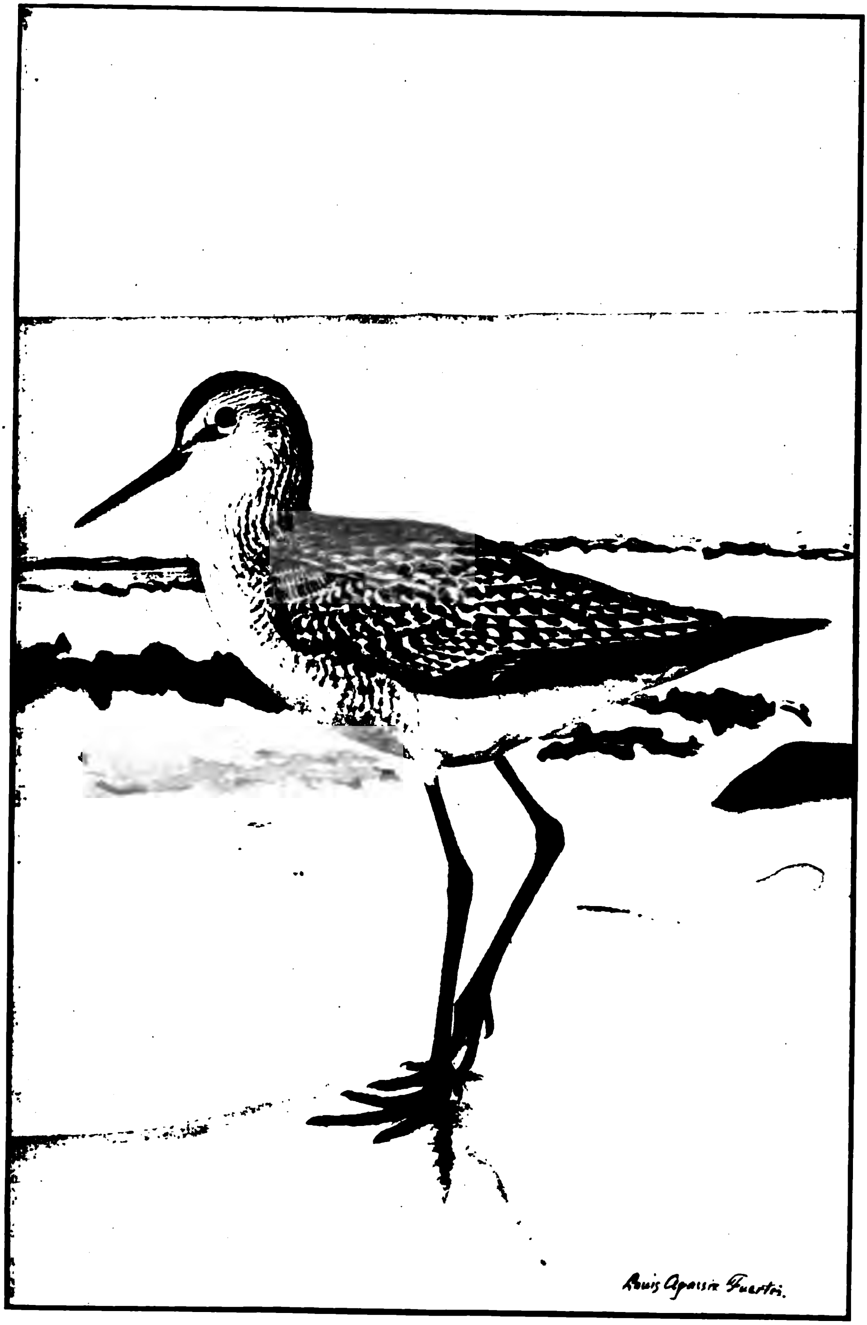
Fall migration.—Hardly six weeks elapse between the passage of the last northward-bound migrants on Long Island, New York, and the appearance of the first fall migrants; on the average the last in spring pass May 28, latest June 14, 1901 (Scott), while the average date of fall arrival is July 19, earliest July 10, 1887 (Scott). The larger flights there do not come until August, and the species is most common in September and October. Formerly this was one of the common species of shorebirds and one much sought by gunners. A hunter near Newport, R. I., shot 1,362 greater yellow-legs in the eight seasons 1867–1874, on dates ranging from July 20, 1870, to November 4, 1870; his highest score, 419 birds, was in 1873, from August 19 to October 19. Dates of fall arrival are: Granville, Wash., July 7, 1897 (Young); Utah Lake, Utah, July 26, 1872 (Henshaw); Aweme, Manitoba, average July 29, earliest July 27, 1901 (Criddle); Lipscomb, Tex., one June 29, common July 8, 1903 (Howell); Pacheco, Chihuahua, July 30, 1905 (Brown); Toronto, Ontario, July 28, 1891 (Nash); Cullingham Cove, Ungava, July 31, 1891 (Norton); Anticosti Island, July 8, 1881 (Brewster); Erie, Pa., July 28, 1896 (Todd); Washington, D. C., July 24, 1890 (Richmond); Bahama Islands, July 6, 1904 (Allen); Barbados, West Indies, July 25, 1886 (Manning); Bonaire Island, off the coast of Venezuela, July 21, 1892 (Hartert).

Dates of the last seen are: Near Fort Churchill, Keewatin, August 8, 1900 (Preble); Hayes Run, Keewatin, August 30, 1900 (Preble); Oxford House, Keewatin, September 10, 1900 (Preble); Cumberland Sound, September 14, 1877 (Kumlien); near Fort Chimo, Ungava, September 19, 1882 (Turner); Portage la Prairie, Manitoba, October 21, 1884 (Nash); Chilliwack, British Columbia, November 17, 1888, (Brooks), November 21, 1889 (Brooks); Long Island, New York, average November 5, latest November 20, 1901 (Scott). The late dates of departure explain the name winter yellow-legs for this species.

Yellow-legs. *Totanus flavipes* (Gmel.).

Breeding range.—The principal summer home of the yellow-legs is the Barren Grounds and neighboring regions to the southward. The species ranges north to southern Ungava (Selwyn), central Keewatin (Preble), and nearly to the Arctic coast in northern Mackenzie (MacFarlane). It breeds north to Kotzebue Sound (Townsend) and Fort Yukon (Dall and Bannister), but apparently does not occur on the northern coast of Alaska. The southern limit of the breeding range is imperfectly known; the species breeds in Yukon at least south to Lake Marsh (Bishop), and in the interior probably to southern Alberta (Macoun), southern Saskatchewan (Macoun), and northern Quebec (Macoun).

Winter range.—The yellow-legs passes south in winter to the Strait of Magellan (Gay) and occurs at this season quite generally over the southern half of South America, and even in the mountains up to 10,000 feet (Sclater). Winter records north of this region are few, and probably only a comparatively small number regularly winter


Louis Agassiz Fuertes.

YELLOW-LEGS (TOTANUS FLAVIPES).

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north of South America. A few winter in southern Mexico, as far north as Cozumel Island (Sharpe) and La Barca, Jalisco (Goldman); a few are noted occasionally in Louisiana (Beyer) and in Florida in winter (Pillsbury), and the species occurs rarely in the Bahamas at this season (Bonhote).

Migration range.—The yellow-legs is common on the Atlantic coast in fall and many pass through the Lesser Antilles. In this latter region it is practically unknown in spring, and it is rare in spring migration on the Atlantic coast north of Long Island, New York. These facts would seem to indicate that some yellow-legs pursue different migration routes in fall and spring. The species is a common migrant in the Mississippi Valley both spring and fall, and hence probably most of those that go south through the Lesser Antilles return in spring to their breeding grounds by way of the Mississippi Valley.

The species is not common on the Atlantic coast north of the Gulf of St. Lawrence, though one was taken October 8, 1882, near Fort Chimo, Ungava (Turner), and two have been taken in southern Greenland (Winge).

The yellow-legs is rarely seen west of the Rocky Mountains, but a few occur along the coast from northern Alaska (Grinnell) to southern Lower California (Brewster). One was taken June 11, 1890, on St. Paul Island (Palmer).

Spring migration.—The following dates show the usual time at which the yellow-legs arrives in its northward migration: Northern Texas, average March 26, earliest March 22, 1899 (Mayer); central Missouri, average April 14, earliest April 9, 1903 (Bryant); Keokuk, Iowa, average April 16, earliest March 11, 1894 (Currier); central Nebraska, average April 28, earliest March 27, 1900 (Wolcott); Chicago, Ill., average April 23, earliest April 15, 1899 (Gault); Oberlin, Ohio, average April 28, earliest April 23, 1904 (Jones); Raleigh, N. C., average April 1, earliest March 25, 1893 (Brimley). The following are dates of occurrence somewhat earlier than the average: Cumberland, Ga., March 12, 1902 (Helme); Washington, D. C., March 12, 1906 (Green); Havre de Grace, Md., March 15, 1895 (Kirkwood); near Newport, R. I., April 28, 1902 (King); Godbout, Quebec, May 5, 1888 (Comeau); San Antonio, Tex., March 20, 1903 (Norton); Bay St. Louis, Miss., March 13, 1902 (Allison); Sioux City, Iowa, March 11, 1864 (Feilner); southern Ohio, March 18, 1901 (Henninger); Lanesboro, Minn., April 7, 1890 (Hvoslef); Fort Lyon, Colo., March 30, 1886 (Thorne); Indian Head, Saskatchewan, April 25, 1892 (Macoun); Edmonton, Alberta, May 1, 1901 (Preble); Fort Reliance, Yukon, May 3 (Nelson); Fort Resolution, Mackenzie, May 5, 1860 (Kennicott); Willow River, Mackenzie, May 9, 1904 (Mills and Jones); Fort Reliance, Mackenzie, May 13, 1834 (Back); Fort

Franklin, Mackenzie, May 16, 1826 (Richardson); Fort Anderson, Mackenzie, May 27, 1865 (MacFarlane). The yellow-legs is thus about the earliest shorebird to reach high northern latitudes.

Eggs were taken at Fort Resolution June 1, 1860 (Kennicott); near Fort Anderson, June 15, 1863, June 20, 1864, and June 16, 1865 (MacFarlane); and downy young July 1, 1899, at Lake Marsh, Yukon (Bishop).

Fall migration.—Like so many other waders, the yellow-legs begins its southward journey early in July, so early indeed that migrants have appeared on the Bermudas by July 13 (Reid). Other dates of fall arrival are: Chilliwack, British Columbia, July 25, 1889 (Brooks); Fort Lyon, Colo., July 23, 1884 (Thorne); Aweme, Manitoba, July 26, 1901 (Criddle); Toronto, Ontario, July 18, 1891 (Nash); near Chicago, Ill., July 3, 1893 (Dunn), abundant by July 25 (Parker); Long Island, New York, July 14, 1887 (Scott), July 9, 1905 (Latham); Long Beach, New Jersey, July 9, 1877 (Scott); James Island, Florida, July 20, 1901 (Williams); Key West, Fla., July 16, 1888 (Scott); Inagua, Bahamas, July 28, 1891 (Cory); Jamaica, August 2, 1891 (Field); the average date of arrival in the Lesser Antilles is about July 25, earliest July 4, 1888 (Feilden); Santo Domingo, Venezuela, July 24, 1903 (Briceno); Fortin Page, Argentina, September 13, 1890 (Kerr). The yellow-legs is one of the earliest birds to migrate in fall, and the greater number have left the breeding grounds by the latter part of August. A few linger quite late, as shown by the following dates of the last seen: Near Fort Chimo, Ungava, October 8, 1882 (Turner); Montreal, Canada, October 7, 1898 (Wintle); Scotch Lake, New Brunswick, October 28, 1901 (Moore); Ottawa, Ontario, October 18, 1901 (White); Lanesboro, Minn., October 11, 1888 (Hvoslef); Oberlin, Ohio, October 18, 1899 (Jones); Long Island, New York, October 18, 1905 (Latham); Erie, Pa., October 14, 1893 (Todd); Lincoln, Nebr., November 17, 1900 (Wolcott).

Solitary Sandpiper. *Helodromas solitarius* (Wils.).

Breeding range.—Few facts are known concerning the breeding range of this species. It has been seen in summer over a great extent of country; the young only a few days old have been noted in widely separated localities, but the nest and eggs are almost unknown. The species as a whole, including the eastern and western forms, ranges north in summer to Newfoundland (Reeks); Fort Chimo, northern Ungava (Turner); Great Bear Lake, Mackenzie (Richardson); and to Kowak River, in northwestern Alaska (Grinnell). The southern limit of the breeding range is entirely undetermined. The birds stay in summer as far south as Pennsylvania (Todd), Illinois (Ridgway), Nebraska (Cary), Colorado (Cooke), and Washington (Dawson).

Winter range.—There seem to be no winter records whatever of the western form of the solitary sandpiper. There is every reason for believing that it winters in South America, and has not been distinguished there from the eastern form. The following statement of the winter range doubtless includes both forms, but it is not safe to conclude that the eastern form goes to eastern South America and the western form to the Pacific coast. It is known that the eastern form migrates to the Pacific coast of Mexico, and it is probable that thence southward the two forms commingle both in migration and during the winter. The species as a whole ranges south in winter to Buenos Aires, Argentina (Barrows); to Caiza, in southeastern Bolivia (Salvadori); and to Chorillos, central Peru (Taczanowski). It occurs regularly also at this season in northern South America to Guiana (Quelch), Venezuela (Berlepsch and Hartert), and Colombia (Salvin and Godman). North of South America it is not common anywhere in winter, and it may not winter at any of the following places, but it has been noted as late as December in Porto Rico (Bowdish), Costa Rica (Todd), Yucatan (Sharpe), Veracruz (Sharpe), and northern Lower California (Stephens).

Migration range.—A specimen was taken in Greenland August 1, 1878, at Kangek, latitude 64° (Hagerup); and one of the eastern form was taken October 28, at San José del Cabo, Lower California (Brewster).

Spring migration.—The following records include both the eastern and western forms: The species arrives in the southern United States in March; Tallahassee, Fla., March 25, 1901 (Williams); Coosada, Ala., March 28, 1878 (Brown); Bay St. Louis, Miss., March 17, 1902 (Allison); New Orleans, La., average March 16, earliest March 5, 1900 (Allison); Boerne, Tex., March 25, 1880 (Brown); while some of the earliest records in California are at Los Angeles, April 21, 1897 (Grinnell), and Gridley, April 23, 1891 (Belding). Further progress northward is decidedly slow, as shown by the following dates of arrival: Raleigh, N. C., average April 24, earliest April 4, 1889 (Brimley); near Asheville, N. C., average April 22, earliest April 9, 1890 (Cairns); Washington, D. C., average April 28, earliest April 25, 1900 (Preble); Englewood, N. J., average April 30, earliest April 28, 1900 (Lemmon); near New York City, average May 4, earliest April 30, 1899 (Thayer); Renovo, Pa., average May 4, earliest May 1, 1897 (Pierce); eastern Massachusetts, average May 6, earliest May 2, 1891 (Long); southwestern Maine, average May 11, earliest April 28, 1903 (Swain); Petitcodiac, New Brunswick, May 14, 1887 (Willis); Pictou, Nova Scotia, May 7, 1894 (Hickman); Lake Mistassini, Quebec, May 23, 1885 (Macoun); central Iowa, average April 25, earliest April 10, 1899 (Savage); Chicago, Ill., average April 23, earliest April 7, 1887 (Coale); Bloomington, Ind., average May 2, earliest April 23, 1903 (McAtee); Oberlin, Ohio, average April 29, earliest April 18, 1909 (Jones); Ottawa, Ontario, average May 11, earliest May 2, 1896 (White); southern Wisconsin, average May 6, earliest April 25, 1897 (Russel); Lanesboro, Minn., average May 6, earliest April 24, 1888 (Hvoslef); near San Antonio, Tex., average April 17, earliest March 25, 1880 (Brown); central Kansas, average May 2, earliest April 23, 1885 (Kellogg); Harrisburg, N. Dak., average May 5, earliest May 3, 1904 (Eastgate); Aweme, Manitoba, average May 13, earliest May 9, 1906 (Criddle); Colorado Springs, Colo., May 1, 1882 (Allen and Brewster); Terry, Mont., May 7, 1903, May 9, 1904 (Cameron); Athabaska Landing, Alberta, May 5, 1901 (Preble); Sandy Creek, Alberta, May 14, 1903 (Preble); Fort Providence, Mackenzie, May 14, 1905 (Jones); Fort Simpson, Mackenzie, May 10, 1904 (Preble); Great Bear Lake, May 14, 1826 (Richardson); Fort Steilacoom, Wash., May 6, 1856 (Suckley); Chilliwack, British Columbia, May 7, 1888 (Brooks); Nulato, Alaska, May 15, 1867, May 18, 1868 (Dall); Kowak River, Alaska, May 18, 1899 (Grinnell).

One of the parties of the Biological Survey took downy young June 23, 1903, at Charlie Creek, Alaska (Osgood); eggs are reported from central Alberta, June 24, 1908, June 15, 1908, June 1 and June 9, 1909 (Thayer and Arnold), and young in the nest were found June 19, 1908, at Stony Plain, Alberta (Stansell).

Fall migration.—Early dates in the fall south of the breeding range are: Washington, D. C., average July 21, earliest July 15, 1899 (Howell); Raleigh, N. C., average July 25, earliest July 14, 1894 (Brimley); Key West, Fla., July 28, 1888 (Scott); New Orleans, La., July 20, 1899 (Kopman); Kerrville, Tex., July 20, 1903 (Lacey); Camp Apache, Ariz., July 29, 1873 (Henshaw); Bermudas, July 19, 1874 (Reid); St. Croix, West Indies, July 26, 1857 (Newton); San José del Cabo, Lower California, August 25, 1887 (Brewster); near Buenos Aires, Argentina, August 20, 1880 (Barrows).

Dates of the last seen are: Chilliwack, British Columbia, September 13, 1889 (Brooks); Aweme, Manitoba, September 18, 1904 (Criddle); Chicago, Ill., October 6, 1899 (Gault); Lincoln, Nebr., October 20, 1900 (Wolcott); Ottawa, Ontario, October 31, 1906 (White); Hillsboro, Iowa, October 20, 1899 (Savage); Delavan, Wis., October 20, 1892 (Hollister); Lexington, Ky., October 23, 1904 (Dean); Pictou, Nova Scotia, October 8, 1894 (Hickman); Scotch Lake, New Brunswick, October 5, 1901 (Moore); southwestern Maine, October 21, 1904 (Norton); Renovo, Pa., October 14, 1897 (Pierce); Chesapeake Beach, Md., November 2, 1906 (Riley).

Western Solitary Sandpiper. *Helodromas solitarius cinnamomeus* (Brewst.).

The western solitary sandpiper occurs in western North America and ranges at least as far east as Great Slave Lake (Preble), Athabaska Lake (Preble), the eastern foothills of the Rocky Mountains in Colorado (Henshaw), and to central Texas (Gaut). It migrates throughout western Mexico and east to Veracruz (Sartorius) and Tehuantepec (Sumichrast). As already stated, the winter range has not yet been determined.

Green Sandpiper. *Helodromas ocrophus* (Linn.).

The green sandpiper, an Old World species, is widely distributed breeding from the Pyrenees to southern Siberia, principally in the mountains. It winters from southern Europe and Japan, throughout Africa, and to Ceylon. It is supposed to have occurred at Halifax, Nova Scotia (Harting), and in the Hudson Bay Company's territory (Nuttall), but the evidence is not conclusive.

Wood Sandpiper. *Rhyacophilus glareola* (Linn.).

The wood sandpiper is one of the best known of the Old World sandpipers. It breeds over most of Europe and Asia from the valley of the Danube and northern China to the Arctic coast. It winters from the Mediterranean and India to southern Africa and the Malay Archipelago. The only record of the species in North America is that of a single specimen taken May 27, 1894, on Sanak Island, Alaska (Littlejohn).

Willet. *Catoptrophorus semipalmatus* (Gmel.).

Breeding range.—The breeding range of the willet on the Atlantic coast has become much restricted of late years. Formerly it bred north, commonly to New Jersey (Giraud), and rarely to Sable Island (eggs in United States National Museum), Yarmouth (Bryant), and Halifax (Brewer), Nova Scotia. It still breeds rather commonly on the islands off the coast of Virginia (Dutcher), and a few may breed in extreme southern New Jersey, but probably at present no willets breed between there and Nova Scotia, where in 1903 it was reported abundant at Barrington (Trotter). It breeds along the south Atlantic coast to Florida (Scott), in Louisiana (Bent), and throughout the Bahamas (Bonhote).

Winter range.—On the Pacific coast it migrates in winter to Santa Lucia, southern Peru (Taczanowski), and on the Atlantic coast to the Amazon River (Pelzeln). It occurs also in winter in northern South America (Quelch), the Lesser and the Greater Antilles, the Bahamas (Bonhote), Florida (Worthington), and casually in South Carolina (Hoxie).

Spring migration.—The willet starts north in March. Some dates of spring arrival are: Hog Island, Virginia, average April 12, earliest April 7, 1888 (Doughty); southern New Jersey, average April 19, earliest April 6, 1877 (Scott); Erie, Pa., April 24, 1902 (Todd). The species has been recorded in migration to Newfoundland (Reeks), but it is not known to breed on that island.

Eggs have been taken in the Bahamas from May 15 (Cory) to July 6 (Allen); Sapelo Island, Georgia, April 22, 1888 (specimens in

United States National Museum); Beaufort, N. C., May 8 (specimens in United States National Museum); Cobbs Island, Virginia, May 25, 1875 (Baily); Warner House, N. J., May 19, 1884 (Bellows); Madison, Conn., June 5, 1873 (Merriam); and on Sable Island in June (specimens in United States National Museum).

Fall migration.—A gunner who shot for the market near Newport, R. I., obtained 106 willets during eight seasons, 1867–1874, on dates ranging from July 11, 1871, to September 19, 1869 (Sturtevant). One bird was seen July 2, 1902, at Sakonnet, R. I. (King). The average date of arrival of late years on Long Island, New York, has been August 13, earliest August 4, 1901 (Scott). The last was seen at Plymouth, Mass., October 4, 1852 (Browne); Long Island, New York, September 24, 1905 (Latham); southern New Jersey, average September 9, latest October 17, 1885 (Crane); Hog Island, Virginia, November 1, 1886, and October 27, 1887 (Doughty).

Western Willet. *Catoptrophorus semipalmatus inornatus* (Brewst.).

Breeding range.—The western willet breeds not uncommonly on the coast of Texas (Merrill), and from northern Iowa (Berry), southern South Dakota (Cheney), and northern California (Beckwith; Christie), north to the southern portions of Manitoba (Thompson), Saskatchewan (Ferry), Alberta (Macoun), and to Central Oregon (Bendire).

Winter range.—The western willet winters on the coasts of Louisiana (Beyer) and Texas (Sennett) and on the coast of California north to Humboldt Bay (Townsend). In winter it ranges south into Mexico (Nelson) and probably to southern Guatemala (Salvin). It also passes eastward and winters on the Gulf coast of Florida (Scott).

Spring migration.—Dates of spring arrival are: Stotesbury, Mo., April 8, 1894 (Surber); Keokuk, Iowa, April 30, 1892 (Currier); Lanesboro, Minn., April 26, 1879 (Hvoslef); central Kansas, average April 30, earliest April 28, 1883 (Lantz); northern Nebraska, earliest May 5, 1893 (Bates); northern North Dakota, average May 3, earliest May 1, 1901 (Eastgate); Indian Head, Saskatchewan, May 6, 1892 (Macoun); northern Colorado, average May 1, earliest April 27, 1887 (Smith); Cheyenne, Wyo., average May 4, earliest April 30, 1888 (Bond); Salt Lake City, Utah, April 28, 1897 (Young); Lewiston, Mont., May 2, 1903 (Silloway); Red Deer, Alberta, May 12, 1892 (Farley); Halleck, Nev., May 5, 1871 (specimen in United States National Museum); Fort Klamath, Oreg., April 22, 1887 (Merrill).

Eggs have been taken at Corpus Christi, Tex., May 17, 1882 (Goss); near Turtle Mountain, Manitoba, May 23, 1883 (Thompson); Oneida County, Idaho, May 21, 1879 (Anderson); near Beckwith, Calif., May 28, 1891 (Christie); Camp Harney, Oreg., May 8, 1878 (Bendire); southern Saskatchewan, June 14, 1906 (Bent). Thus the nesting season is about the same throughout the whole breeding range.

Fall migration.—In fall the western willet wanders eastward far beyond the breeding range, even to the Atlantic coast, as shown by the following records: Chicago, Ill., September 2, 1906 (Armstong and Lawson); Miller, Ind., August 14, 1897 (Woodruff); Oberlin, Ohio, September 17, 1906 (Jones); Toronto, Ontario, July 20, 1898 (Fleming); Stony Creek, Conn., August 15, 1897 (Bishop); Keokuk, Iowa, October 27, 1896 (Currier). A wanderer far north of the breeding range was taken at Victoria, British Columbia, August 18, 1898 (Fannin).

Wandering Tattler. *Heteractitis incanus* (Gmel.).

The first information of the breeding range of the wandering tattler was obtained in 1904 by one of the parties of the Biological Survey. A downy young was shot September 5 on Macmillan River in east central Yukon (Osgood). July 28, 1906, a pair were seen by Charles Sheldon near Mount McKinley, south central Alaska, under conditions that left no doubt that they were breeding in the immediate vicinity. It is not probable that the species breeds anywhere south of Alaska, and yet it occurs in the Hawaiian Islands every month of the year (Henshaw); on the coast of California every month from March to October (Bryant), and has been taken July 2, 1900, on the island of Guam, and July 17, 1904, on the Philippine Islands (specimens in the United States National Museum). The species ranges north to Nulato, Alaska (Dall), where it is said by the natives to breed, and occurs about as far north on the Asiatic side of Bering Sea to Plover Bay (Bean), where it was taken in fall migration.

The wandering tattler winters in southern California, the Galapagos (Sharpe), the Hawaiian Islands (Henshaw), and throughout Oceania to the New Hebrides. In migration it occurs on the Commander Islands, along the whole western coast of North America from Mexico to Alaska, and has occurred inland, accidentally at Crater Lake, Oreg. (Bendire), and on the eastern shore of James Bay (Bell).

Spring migration begins in March, bringing the birds to the coast of California (Grinnell) by the latter part of the month. The Aleutian Islands are reached the middle of May (Nelson), and the most northern part of the range by the latter part of the month (Dall).

On the coast of central California, nearly 2,000 miles south of the breeding grounds, the first fall migrants appear with great regularity within a few days of the middle of July, and are common a few days later (Loomis). At about the same time the birds return from the interior of Alaska to the coast, and are common around Bering Sea for the next two months (Nelson). The last leave the northern part of the range about the middle of September (Nelson) and desert the Aleutians a month later (Bishop).

Ruff. *Machetes pugnax* (Linn.).

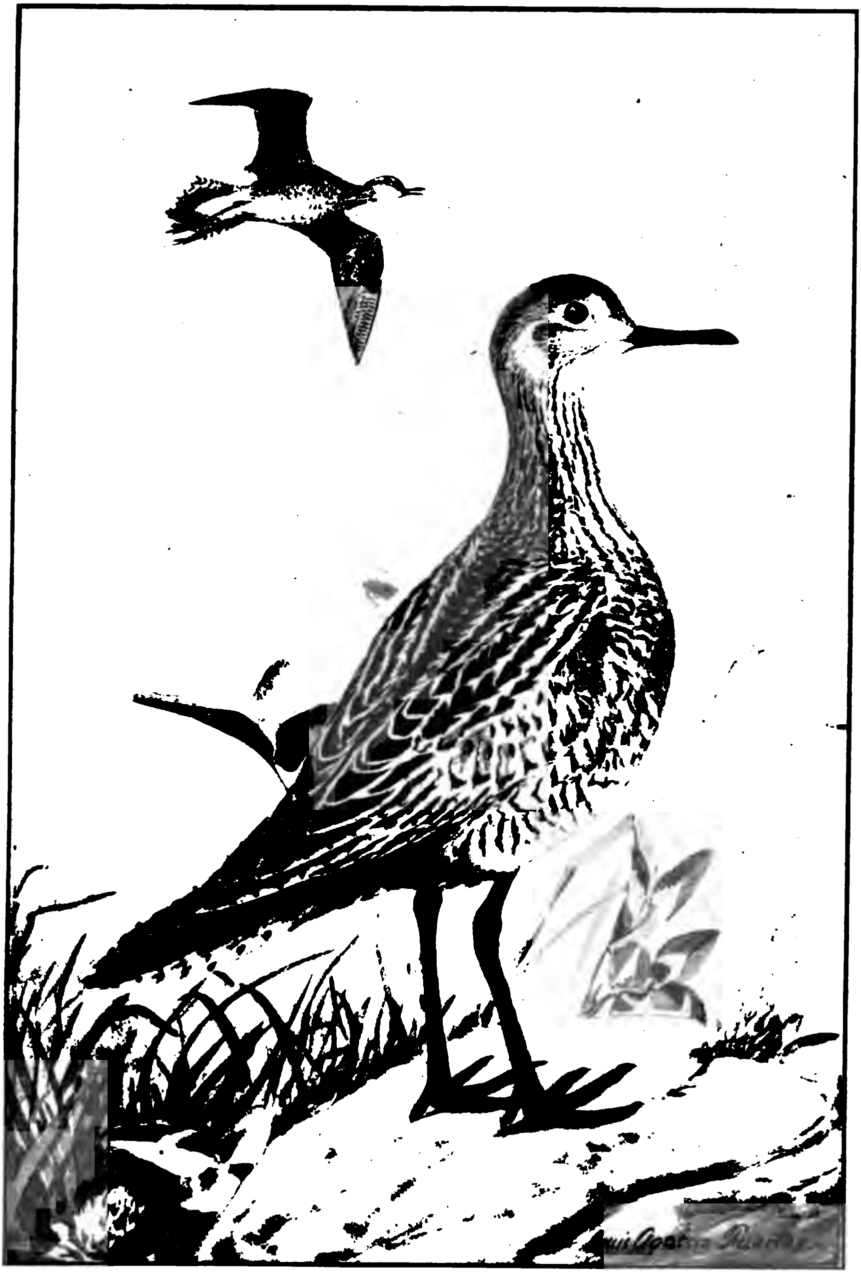
Though an Old World species, the ruff has been taken many times in the Western Hemisphere at widely separated localities as follows: One at Nanortalik, on the southwest coast of Greenland, (Fenckers); Toronto, Ontario, spring of 1882 (Seton); English Lake, Ind., April 12, 1905 (Deane); a specimen in the Ohio State University collection bears the label, "Northern Canada, April 28, 1877" (Dawson); Licking Reservoir, Ohio, November 10, 1872 (Wheaton); Columbus, Ohio, April 28, 1878 (Jones); Grand Manan, New Brunswick, no date (Boardman); Cole Harbor, near Halifax, Nova Scotia, May 27, 1892 (Brewster); Upton, Me., September 8, 1874 (Brewster); Scarborough, Me., April 10, 1870 (Smith); Camden, Me., September 14, 1900 (Thayer); Seabrook, N. H., September 24, 1907 (Hardy); Newburyport, Mass., May 20, 1871 (Brewster); Chatham, Mass., September 12, 1880 (Grinnell); Nantucket, Mass., July, 1901 (Palmer); near Sakonnet Point, Rhode Island, July 30, 1900 (Hathaway); Point Judith, Rhode Island, August 31, 1903 (King); Long Island, New York, one in fall, 1845 (Lawrence), one in October, 1851 (Lawrence), one in May 18, 1868 (Chapman); another specimen seems to have been taken on Long Island, but the date is not recorded (DeKay); Barnegat, N. J., no date (Chapman); Four Mile Run, Va., September 3, 1894 (Palmer); Raleigh, N. C., May 6, 1892 (Brimley); Barbados Island, one before 1848 (Schomburgk), and one in 1878 (Feilden); one in "Spanish America," which probably means near the headwaters of the Rio Negro in northern South America (Pelzeln).

It is thus seen that the ruff has been taken in this hemisphere at least 27 times. Seven of the specimens have no date recorded; 9 were secured in the spring between April 10 and May 27; the other 11 were taken in the fall from July 30 to November 10. As would be expected, most of the specimens are from near the Atlantic coast; only 5 occurred in the interior, the westernmost being the one at English Lake, Indiana.

The breeding range of the ruff is from Great Britain to central Siberia and north to the Arctic coast. The bird winters in Burma, India, and to the southern part of Africa. It has wandered east in Asia to Japan and the Commander Islands, but has not yet been detected on the western coast of America.

Upland Plover. *Bartramia longicauda* (Bechst.).

Breeding range.—The upland or field plover, sometimes called the Bartramian sandpiper, is one of the few shorebirds that nest commonly in the Mississippi Valley. Early in the settlement of this region, much more than half the upland plovers probably nested within the boundaries of the United States. The center of abundance during the breeding season was the prairie region from Kansas to Manitoba.



UPLAND PLOVER (BARTRAMIA LONGICAUDA).

The numbers were not greatly diminished so long as this region was used for stock purposes, but recently the birds have rapidly decreased. At the present time the species breeds south to southern Oregon (Merrill); northern Utah (Ridgway); northern Colorado (Rockwell), central Oklahoma (Merrill), southern Missouri (Prior), southern Indiana (Butler), northern Virginia (Grinnan) and central Maryland (Miller). The summer range extends north to southern Maine (Norton), southern Ontario (Renfrew; Clarke), and southern Michigan (Wood). Then it bends far to the northward through central Wisconsin (Kumlien and Hollister) to central Keewatin (Cape Eskimo; Preble), southern Mackenzie (Fort Smith; Preble), northern Yukon (M'Dougall), and to the Kowak River in northwestern Alaska (Townsend). Stragglers are not uncommon in the Maritime Provinces and have occurred in Newfoundland (Reeks) and to Godbout, Quebec (Merriam). The species is not common east of Michigan nor west of the Rocky Mountains.

Winter range.—The principal winter home is in Argentina (Sclater and Hudson) and probably no upland plovers occur at this season north of the pampas of South America.

Migration range.—In fall this species passes through the Greater and the Lesser Antilles (Feilden), but in the Bahamas (Cory), Jamaica (March), and Porto Rico (Gundlach), it is so much rarer than farther east as to indicate that some individuals reach the Lesser Antilles by direct flight across the ocean. It migrates also through the Gulf States and west to Sulphur Spring, Ariz. (Henshaw), western Mexico (Durango; Nelson), and locally in Central America and the northern parts of South America.

There seem to be no spring records of migration in the West Indies east of Cuba, indicating that the individuals that go south through the Lesser Antilles return by way of Central America. Nor in spring migration is the species recorded west of central Mexico or west of the Rocky Mountains south of Utah. The only record for California is the single bird taken by Vernon Bailey of the Biological Survey at Tule Lake, August 8, 1896.

Spring migration.—The upland plover arrives in Louisiana on the average earlier than in either Florida or Texas. This would seem to prove that it reaches Louisiana by direct flight across the gulf. The average date of arrival in southern Louisiana is March 14, while the date of arrival at the same latitude in Texas is March 28, and in Florida is early April. The earliest dates are: Bonham, Tex., March 5, 1887 (Peters); New Orleans, La., March 9, 1895 (Beyer); and Tallahassee, Fla., March 25, 1901 (Williams). Other dates of arrival on the Atlantic slope are: Raleigh, N. C., average April 7, earliest March 28, 1896 (Brimley); Washington, D. C., March 21, 1896 (Richmond); Holland Patent, N. Y., average April 20, earliest

April 14, 1896 (Williams); central Connecticut, average April 29, earliest April 16, 1896 (Jennings); southern New Hampshire, average April 30, earliest April 22, 1900 (Dearborn); Plymouth, Me., average May 3, earliest April 25, 1878 (Thorne); central Vermont, average May 5, earliest April 30, 1887 (Goodwin); Godbout, Quebec, May 7, 1885 (Merriam).

Migration in the Mississippi Valley begins earlier than on the Atlantic coast and is earlier for corresponding latitudes all the way north to the Canadian boundary, as shown by the following dates of arrival: Odin, Ill., average April 4, earliest March 30, 1895 (Vandercock); Tampico, Ill., average April 11, earliest April 9, 1890 (Brown); Chicago, Ill., average April 16, earliest April 10, 1896 (Gault); Oberlin, Ohio, average April 14, earliest March 22, 1904 (Jones); southern Michigan, average April 20, earliest April 8, 1895 (Alexander); central Iowa, average April 15, earliest April 3, 1893 (Ross); southern Wisconsin, average April 18, earliest April 10, 1853 (Stiles); Heron Lake, Minnesota, average April 24, earliest April 20, 1890 (Miller); Manhattan, Kans., average April 14, earliest April 4, 1882 (Lantz); Onaga, Kans., average April 14, earliest April 7, 1893 (Crevecoeur); southern Nebraska, average April 17, earliest April 6, 1890 (Wilson); northern Nebraska, average April 18, earliest April 7, 1903 (Colt); central South Dakota, average April 23, earliest April 19, 1886 (Cheney); Argusville, N. Dak., average May 5, earliest April 26, 1894 (Edwards); Larimore, N. Dak., average May 5, earliest April 26, 1888 (Eastgate); Aweme, Manitoba, average May 3, earliest April 26, 1899 (Criddle); Lake Como, Wyoming, May 5, 1879 (Williston); Rathdrum, Idaho, average May 12, earliest April 27, 1901 (Danby); Columbia Falls, Mont., average May 12, earliest April 27, 1894 (Williams); Edmonton, Alberta, May 12, 1903 (Preble); Red Deer, Alberta, May 13, 1892, May 11, 1893 (Farley); 150-mile House, British Columbia, May 16, 1901 (Brooks).

In the winter home in Argentina the northern movement begins in February, and most birds are gone by the end of March; a few stragglers remain to April (Sclater and Hudson). The species passes through Peru in March and April (Sclater and Salvin); the last was seen at Piedra Blanca, Bolivia, April 23 (Allen); at Tonantins, Brazil, May 7, 1884 (Berlepsch); Cabanas, Cuba, May 22, 1900 (Palmer and Riley); Teopisca, Chiapas, May 7, 1904 (Goldman); and New Orleans, La., May 19, 1894 (Allison).

Eggs have been secured at Lawrenceville, N. J., May 18, 1889 (Phillips); Holland Patent, N. Y., May 21, 1886 (Williams); Marthas Vineyard, Mass., May 25, 1900 (Durfee); Cornwall, Vt., May 26, 1889 (Parkhill); Philo, Ill., May 4, 1900 (Hess); Winnebago, Ill., May 10, 1864 (Tolman); near Dubuque, Iowa, May 14, 1865 (Blackburn); Beatrice, Nebr., May 16, 1895 (Pearse); near Bryant, S. Dak., May 26, 1895 (Lee); Lewistown, Mont., May 25, 1904 (Silloway); Carberry, Manitoba, May 30, 1886 (Seton); southwestern Saskatchewan, May 29, 1905 (Bent).

Fall migration.—Birds were observed at Lipscomb, Tex., July 10, 1903 (Howell), and as they do not breed in that locality, these were southbound migrants. Observers easily detect the call notes of the upland plover as it passes overhead in the darkness, and these calls are usually the first signs of the fall migration. The earliest notes in 1895 at Baltimore, Md., were heard July 3, 1895 (Kirkwood); at Washington, D. C., the first calls have been heard usually between July 10 and July 16, while in 1896 the birds were seen July 7 (Richmond). The average date of arrival in southern Louisiana is July 23, earliest July 9, 1895 (Blakemore); Gainesville, Tex., July 13, 1885 (Ragsdale); Fort Lyon, Colo., July 12, 1886 (Thorne); Sulphur Springs, Ariz., August 18, 1874 (Henshaw); Chapala, Jalisco, August 27 (Richardson); San Jose, Costa Rica, September 5, 1890 (Cherrie); Barbados, West Indies, August 12, 1886 (Manning); Cienega, Colombia, September 15, 1898 (Allen). In September they first appear on their passage through Peru (Sclater and Salvin), and are noted as arriving at their winter home in Argentina (Sclater and Hudson). The last one was seen September 6, 1903, at Big Sandy, Mont. (Coubeaux); at Fort Lyon, Colo., September 2, 1886 (Thorne); near Cape Eskimo, Keewatin, August 13, 1900 (Preble); Aweme, Manitoba, average September 6, latest September 28, 1897 (Criddle); Onaga, Kans., average September 14, latest October 15, 1896 (Crevecoeur); southern Iowa, average September 20, latest September 30, 1896 (Savage); Livonia, Mich., September 18, 1891 (Alexander); Detroit, Mich., October 20, 1902 (Swales); Chicago, Ill., average September 6, latest September 22, 1906 (Armstrong and Lawson); Lexington, Ky., October 11, 1903 (Dean); New Orleans, La., October 7, 1896 (Kopman); North River, Prince Edward Island, August 25, 1887 (Bain); Pittsfield, Me., September 22, 1895 (Morrell); Taunton, Mass., September 19, 1889 (Scudder); Germantown, Pa., October 2, 1887 (Stone); Key West, Fla., October 3, 1888 (Scott); near Atlanta, Ga., November 27, 1903 (Smith); Escondido, Nicaragua, November 26, 1892 (Richmond); San Jose, Costa Rica, November 15, 1889 (Cherrie); Davila, Panama, November 30, 1900 (Bangs).

Buff-breasted Sandpiper. *Tryngites subruficollis* (Vieill.).

Summer range.—The buff-breasted sandpiper is known to breed from Point Barrow, Alaska (Murdoch), to near Franklin Bay, Mackenzie (MacFarlane). It was taken in June at Repulse Bay (Rae), and undoubtedly breeds along the whole Arctic coast east to Hudson Bay. Not quite so certain is the breeding of the bird on the coast of northeastern Siberia. It was found to be quite common there near Koliuchin Bay, August 1, 1881 (Nelson), and had probably bred there, but no nests or young were found, and the individuals seen may have been early fall wanderers from Alaskan breeding grounds.

Winter range.—It winters in Argentina and Uruguay, south at least to Buenos Aires (Durnford) and Montevideo (Gould).

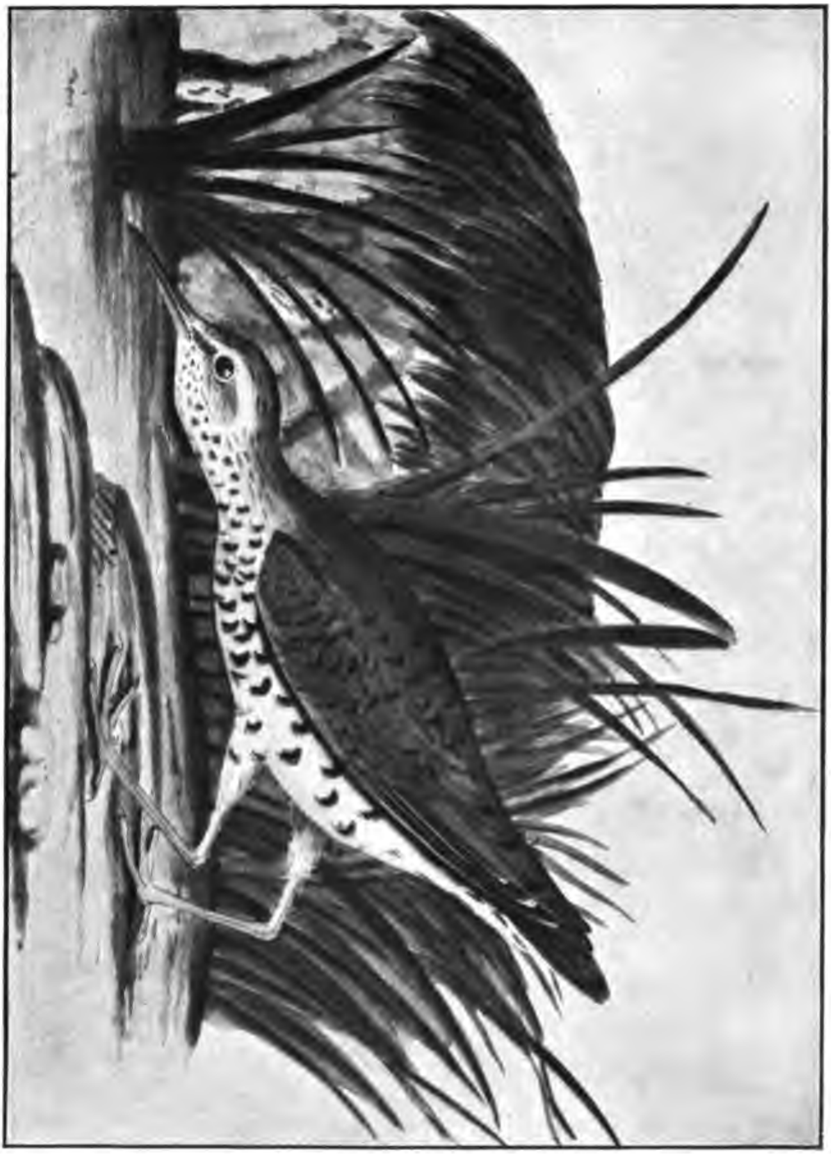
Migration range.—Many thousand miles separate the summer and winter homes of the species, and the migration route between these widely separated regions seems to be somewhat different from that of any other species. The main body of migrants follows the Barren Grounds to the shores of Hudson Bay, thence almost due south across the Mississippi Valley to the coast of Texas and through Central America to northwestern South America and diagonally across the interior of South America to Argentina.

The buff-breasted sandpiper is a rare fall migrant on the Atlantic coast: Henley Harbor, Labrador, August 20, 1860 (Coues); Port Burwell, Ungava, September 28, 1884 (Bell); Quebec, three records, August 28 (Merriam) to September (Trowbridge); Cape Elizabeth, Me., September 13, 1887 (Knight); Scarboro, Me., September 5, 1907 (Norton); several records on the coast of New England and on Long Island, the latest of which is September 11, 1904, on Long Island (Braislin). South of Long Island there are no recent records, and most of the older ones are open to suspicion. The species was seen once in April in Cuba (Gundlach), twice in the fall on Barbados (Feilden), and a record for the island of Trinidad (Leotaud) is somewhat doubtful. It is practically unknown in spring on the Atlantic coast of the United States. It has been taken at Barr Lake, Colo. (Hersey), and on the Pacific coast has been taken at Cape Flattery, Wash. (Newberry); in southern British Columbia (Brooks); Sitka (Bischoff), St. Michael (Nelson), and Nulato (Dall and Bannister), Alaska.

Spring migration.—Migrants appear in the interior of Brazil (Pelzeln) and in Peru (Sclater and Salvin) during March, but there are no spring migration data for the whole distance between Peru and Texas. In the State of Texas the species was noted April 22, 1887, in Refugio County (Sennett), and April 23, 1877, at Gainesville (Ragsdale). The first were seen at Fort Chipewyan, May 24, 1901 (Preble); Fort Simpson, May 29, 1860 (Ross); Yukon delta, May 30, 1879 (Nelson); St. Michael, May 31, 1880 (Nelson); Point Barrow, June 8, 1882 (Murdoch), and June 6, 1883 (Murdoch).

Eggs were taken on the Barren Grounds near Franklin Bay, June 26, 1864, and June 28, 1865 (MacFarlane); and at Point Barrow, June 18, 1883 (Murdoch).

Fall migration.—The fall migration of this species and of most other waders begins in July, and so rapidly do the birds move south that they have been noted the last of this month in Nebraska (Bruner, Wolcott, and Swenk); Gainesville, Tex., August 4, 1883 (Ragsdale); San Jose, Costa Rica, September 7, 1890 (Cherrie); and Cienega, Colombia, September 12, 1898 (Allen). The southern part of the



SPOTTED SANDPIPER (ACTITIS MACULARIA).

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winter range in Argentina is reached early in October (Sclater and Hudson). A very early migrant was taken August 3, at Pebas, Peru (Sharpe). Usually the species is rare east of the Mississippi River, but several flocks were seen August 16–18, 1874, at Maywood, Ill., near Chicago (Fisher).

Spotted Sandpiper. *Actitis macularia* (Linn.).

Breeding range.—Few shorebirds have so extended a breeding range as the spotted sandpiper. It nests north to Newfoundland (Reeks), the northernmost part of Ungava (Turner), northern Mackenzie (Fort Anderson; MacFarlane), northern Alaska at Fort Yukon (Lockhart), and to the Kowak Valley in northwestern Alaska (Townsend). It breeds south to northern South Carolina (Chester County; Loomis), central Alabama (Greensboro; Avery), southern Louisiana (New Orleans; Beyer), central Texas (Lacey), southern New Mexico (Carlisle; Barrell), central Arizona (San Francisco Mountains; Mearns), and the southern Sierra of California (Walker Pass; Kaeding), and probably on the Colorado River near Needles (Hollister).

Winter range.—The spotted sandpiper ranges south in winter to central Peru (La Merced; Berlepsch and Stolzmann), central Bolivia (San Francisco; Salvadori), and to southern Brazil (Sao Paulo; Ihering). It is not rare in northern South America, and is tolerably common in Central America and Mexico; a few winter in the West Indies, and a small number in the eastern United States to the coast of Georgia (Helme) and to Port Royal, S. C. (Eaton), and in the western United States to southern Arizona (Dwight) and southern California (Grinnell).

Spring migration.—The spotted sandpiper passes north about the middle of the migration season, as shown by the following dates of arrival: Northern Florida, average March 19 (Pleas); Raleigh, N. C., average April 10, earliest April 3, 1893 (Brimley); near Asheville, N. C., average April 13, earliest April 10, 1891 (Cairns); Washington, D. C., average April 22, earliest April 2, 1905 (McAtee); near Waynesburg, Pa., average April 13, earliest April 6, 1893 (Jacobs); Beaver, Pa., average April 20, earliest April 2, 1888 (Todd); Renovo, Pa., average April 18, earliest April 9, 1904 (Pierce); Erie, Pa., earliest April 18, 1900 (Todd); near New York City, average April 26, earliest April 15, 1891 (Burhaus); central Connecticut, average April 25, earliest April 20, 1901 (Case); near Providence, R. I., average May 2, earliest April 21, 1905 (Mason); eastern Massachusetts, average April 28, earliest April 15, 1893 (Metcalf); Randolph, Vt., average May 5, earliest April 28, 1891 (Paine); southern New Hampshire, average May 4, earliest April 28, 1905 (Perkins); southwestern Maine, average May 1, earliest April 14, 1904 (Norton); Montreal, Canada, average May 13, earliest April 26, 1890 (Wintle); central New Brunswick, average May 11, earliest May 5, 1906 (McIntosh); Pictou, Nova Scotia, average May 7, earliest May 3, 1895 (Hickman); North River, Prince Edward Island, average May 14, earliest May 11, 1890 (Bain). The earliest date of arrival at New Orleans, La., is March 19, 1904 (Kopman); Athens, Tenn., average April 14, earliest April 10, 1906 (Gettys); Russellville, Ky., April 9, 1906 (Embody); Brookville, Ind., average April 20, earliest April 14, 1883 (Butler); Waterloo, Ind., average April 27, earliest April 5, 1895 (Hine); Chicago, Ill., average April 30, earliest April 19, 1896 (Gault); Oberlin, Ohio, average April 16, earliest April 9, 1904 (Jones); Petersburg, Mich., average April 22, earliest April 15, 1887 (Trombly); southern Ontario, average April 23, earliest April 13, 1896 (Taverner); Ottawa, Ontario, average April 30, earliest April 24, 1897 (White); southern Wisconsin, average April 27, earliest April 23, 1897 (Russell); Lanesboro, Minn., average April 28, earliest April 18, 1886 (Hvoslef); Onaga, Kans., average May 5, earliest April 26, 1896 (Crevecoeur); Aweme, Manitoba, average May 8, earliest May 2, 1905 (Criddle); Columbia Falls, Mont., average May 7, earliest May 4, 1896 (Williams); Chilliwack, British Columbia, May 9, 1889 (Brooks); Athabaska Landing, Alberta, May 6, 1901 (Preble); Fort Chipewyan, Alberta, May 23, 1893 (Russell); near Fort Providence, Mackenzie, May 17, 1904 (Mills); Fort Simpson, Mackenzie, May 19, 1904 (Preble); Dawson, Yukon, May 24, 1899 (Cantwell); Kowak Valley, Alaska, May 22, 1899 (Grinnell). The species has been seen south of its breeding grounds as late as May in Brazil (Pelzeln), and to the latter part of June on the northern coast of Venezuela (Robinson). The species regularly remains in Cuba (Gundlach) and the Bahamas to early May (Bonhote) and in Mexico to the latter part of the month (Sharpe). The average date of the last seen in northern Florida is May 12, and the latest May 18, 1904 (Pleas).

The date of the laying of the eggs varies but little over the whole extent of the breeding range, as shown by the following dates when the earliest eggs were found: Near Richmond, Va., May 22, 1881 (Robinson); Erie, Pa., May 24, 1893 (Todd); Lawrenceville, N. J., May 27, 1889 (Phillips); Trenton Falls, N. Y., May 19, 1892 (Williams); Canaan, Conn., May 16, 1887 (Tobey); Fall River, Mass., May 14, 1887 (Durfee); Orono, Me., May 24, 1894 (Knight); Montreal, Canada, June 8, 1890 (Wintle); Dunnville, Ontario, May 17, 1884 (McCallum); Big Charity Island, Michigan, May 20, 1903 (Arnold); Cheyenne, Wyo., May 30, 1889 (Bond); Fort Lapwai, Idaho, May 29, 1871 (Bendire); Fort Resolution, Mackenzie, May 23, 1860 (Kennicott); Fort Anderson, Mackenzie, June 9, 1862 (MacFarlane); Fort Yukon, Alaska, June 15, 1862.

Fall migration.—The individual taken on Barbados, West Indies, July 4, 1888 (Feilden), may have been a nonbreeding summer resident, or an early fall migrant, but by the end of July migrants have appeared in the Lesser Antilles, on the coast of Venezuela (Hartert), and in Mexico (Brown); indeed, in 1892 a specimen was taken in northern Lower California the first day of July (Mearns).

The last seen at Chilliwack, British Columbia, was October 9, 1888 (Brooks); average of the last seen at Columbia Falls, Mont., September 19, latest September 22, 1895 (Williams); Aweme, Manitoba, average September 5, latest September 11, 1903 (Criddle); Lincoln, Nebr., September 29, 1900 (Wolcott); Lawrence, Kans., October 14, 1905 (Wetmore); Lanesboro, Minn., November 2, 1886 (Hvoslef); Ottawa, Ontario, average September 18, latest October 28, 1902 (White); southern Ontario, average September 30, latest October 25, 1902 (Saunders); Oberlin, Ohio, average September 20, latest October 30, 1905 (Jones); Scotch Lake, New Brunswick, October 5, 1901 (Moore); southwestern Maine, average October 1, latest October 6, 1900 (Johnson); eastern Massachusetts, average October 7, latest November 14 (Townsend); Hartford, Conn., average October 8, latest October 12, 1902 (Case); Ossining, N. Y., October 23 (Fisher); Washington, D. C., October 28, 1906 (Fisher); near New Orleans, La., latest November 5, 1902, November 10, 1903 (Allison).

Long-billed Curlew. *Numenius americanus* Bechstein.

Breeding range.—The principal summer home of the long-billed curlew is in the interior of the United States on the northern half of the plains. Southward it has been known to breed to Oklahoma (Camp Supply; Wilcox), northwestern Texas (McCauley), central New Mexico (Los Pinos; Woodhouse), southern Arizona (Sulphur Spring; Henshaw), and northwestern California in the Pit River region (Grinnell). To the northward it breeds to central British Columbia (150-mile House; Brooks), southern Alberta (Bow River; Macoun), southern Saskatchewan (Medicine Hat; Macoun), and southern Manitoba (Seton). The long-billed curlew was formerly common in the eastern part of the Mississippi Valley and abundant on the Atlantic coast, but of late years the numbers have been so reduced that now it is merely casual or accidental east of the Mississippi. There are records of the former breeding of the species in northern Iowa (Preston), Wisconsin (Hoy), southern Michigan (Jackson; Davis), and northern Illinois (Ridgway). The species was an abundant migrant on the southern Atlantic coast and less common north to Newfoundland (Reeks), and there are various surmises that it bred at various places, such as the west coast of Florida (Scott), coast of New Jersey (Wilson), and Prince Edward Island (Boardman), but most if not all of these breeding records were based on the presence of the birds in July, and there seems to be no authentic record of eggs anywhere east of Michigan.

Winter range.—The species winters on the Atlantic coast from South Carolina (Nuttall) to Florida (Allen); on the coast of Louisiana (Beyer) and Texas (Merrill); in southern Arizona (specimen in United

States National Museum); and in California north to Owen Lake (Fisher) and San Francisco (Newberry). It also ranges south through Mexico to the Pacific coast of Guatemala at Chiapam (Salvin). It is a casual wanderer in the West Indies; Cuba, June, July, October (Gundlach); Jamaica, July, 1863 (March); St. Vincent, once in the fall (Lawrence).

Spring migration.—When the long-billed curlew was common on the Atlantic coast, it was seldom seen in spring north of the Carolinas; the few individuals that passed up the New England coast usually appeared in May: Hail Point, Maryland, May 23, 1893 (Kirkwood); Scarboro, Me., May 2, 1866 (Knight). Migration in the Mississippi Valley begins in March: Eagle Pass, March 5, 1885 (Negley); Pecos City, March 9, 1906 (Ligon); Gainesville, March 4, 1876 (Ragsdale)—all in Texas; Warrensburg, Mo., April 1, 1874 (Scott); Appleton City, Mo., April 3, 1906 (Prier); central Illinois, average April 9; Jasper, Ind., April 2, 1896 (Butler); central Iowa, average April 11, earliest April 3, 1883 (Lindley); northern Nebraska, average April 3, earliest March 28, 1889 (Bates); Vermilion, S. Dak., April 5 ,1884 (Agersborg); central North Dakota, average April 15, earliest April 8, 1886 (Edwards); Aweme, Manitoba, average April 22, earliest April 9, 1902 (Criddle); Apache, N. Mex., March 25, 1886 (Anthony); Utah Lake, Utah, March 30, 1899 (Johnson); northern Colorado, average April 14, earliest April 10, 1889 (Smith); Cheyenne, Wyo., average April 18, earliest April 15, 1889 (Bond); Terry, Mont., average April 16, earliest April 7, 1906 (Cameron); Big Sandy, Mont., average April 19, earliest April 13, 1903 (Coubeaux); Fort Klamath, Oreg., March 28, 1887 (Merrill); Chelan, Wash., April 6, 1896 (Dawson); Okanagan Landing, British Columbia, April 12, 1906 (Brooks).

Eggs have been taken at Camp Harney, Oregon, April 30, 1876 (Bendire); Fort Klamath, Oreg., May 7, 1878 (Mearns); Lewistown, Mont., May 13, 1902 (Silloway); Fort Lapwai, Idaho, May 21, 1871 (Bendire); Cody, Nebr., young just hatched June 23, 1895 (Trostler); southern Saskatchewan, downy young June 1, 1905 (Bent); June 11 and 18, 1906 (Bent).

Fall migration.—Flocks of fall migrants used to appear on the Atlantic coast about the middle of July (Mearns) and reach South Carolina by early August (Hoxie). They returned to Monterey Bay, California, July 17, 1894 (Loomis), and arrived at Cape St. Lucas, Lower California, September 15, 1859 (Xantus). The last one seen at Montreal in 1893 was observed September 21 (Wintle), and on the coast of Massachusetts the species has been noted to October 18 (Howe and Allen).

Hudsonian Curlew. *Numenius hudsonicus* **Lath.**

Breeding range.—The Hudsonian curlew, or jack curlew as it is called by sportsmen, is known to breed on the barren grounds of northern Mackenzie (MacFarlane) and on the western coast of

Alaska from the mouth of the Yukon (Nelson) north to Kotzebue Sound (Grinnell).

Winter range.—The principal winter home is on the Pacific coast, where the species ranges from Ecuador (Salvadori and Festa) to southern Chile (Chiloe Island; Pelzeln), and is especially abundant toward the southern limit of the range. At this season it occurs also on the coasts of Honduras (Taylor) and Guatemala (Salvin) and north to the southern portion of Lower California (Belding). On the Atlantic coast it occurs during the winter from British Guiana (Quelch) to the mouth of the Amazon (Sharpe).

Migration range.—The species probably does not breed in Greenland, but it has been taken several times on the western coast as far north as Jacobshaven, latitude 69° N. (Winge). It migrates east to Ungava (Turner) and Newfoundland (Reeks), and passes down the Atlantic coast and through the Lesser Antilles to its winter home; but it is almost unknown in the Greater Antilles and in Central America and northwestern South America from Nicaragua to Venezuela. It is a common migrant and a probable breeder along the western shore of Hudson Bay (Preble), but since it is unknown in Saskatchewan and Manitoba it is evident that these Hudson Bay birds turn southeastward and probably reach the New England coast; for the bird is more common on the Massachusetts coast than would be expected from the few individuals that occur in Labrador. The species is scarcely recorded in the whole Rocky Mountain district between central Nebraska and eastern California, and it is a rare migrant in the Mississippi Valley, though a few use this route in both migrations. The main migration route is along the Pacific coast, and it occurs here west to St. Paul Island, Alaska (Palmer).

Spring migration.—Records of arrival in the eastern United States are: Sarasota Bay, Florida, March 22, 1872 (Moore); Port Royal, S. C., April 14 (Mackay); Cobbs Island, Virginia, May 19, 1891 (Kirkwood); Cape May, N. J., April 12, 1907, "ten days ahead of the usual time" (Hand); Shelter Island, N. Y., May 9, 1887 (Worthington); Nantucket, Mass., April 10, 1891 (Mackay); but usually not in Massachusetts before the middle of May. By what route these birds reach the eastern United States coast is as yet unknown, for there are no corresponding records in either the Lesser or the Greater Antilles.

The main migratory flocks reach the coast of southern California the middle of March (Grinnell) and proceeding slowly northward have been noted at Fort Kenai, Alaska, May 18, 1869 (Bischoff); Nulato, Alaska, May 12, 1866 (Pease); Kowak Valley, Alaska, May 17, 1899 (Grinnell); Fort Anderson, Mackenzie, May 29, 1865 (MacFarlane).

Eggs were taken on the barren grounds west of the lower Anderson River in late June and early July (MacFarlane), and in the Kowak Valley June 14–20, 1899 (Grinnell).

Fall migration.—On the western shore of Hudson Bay near York Factory in 1900 the species was seen July 19, and was tolerably common in that region nearly to the first of September (Preble); the earliest date at Toronto, Ontario, is July 4, 1904 (Fleming). The average date of arrival at Nantucket, Mass., is July 20, earliest July 13 (Mackay); earliest at Long Beach, N. J., July 9, 1879 (Stone); Pea and Bodie Island, North Carolina, July 22, 1904 (Bishop); Bermudas, August 14 (Reid); Barbuda, West Indies, August 12, 1877 (Ober). Two specimens were taken July 3, 1907, at Coronado de Terraba, Costa Rica (Carriker), but these may have been nonbreeders that had not made a northern journey.

The individuals breeding in Alaska pass south along the Pacific coast, and have been noted at the Farallons, California, July 16, 1896 (Loomis); Los Coronados Islands, Lower California, August 7, 1902 (Grinnell and Daggett); Chimbote, Peru, August 2–5, 1883 (MacFarlane); and by August 18, at Arauca, Chile (Sharpe).

The Hudsonian curlew has been noted at St. Michael, Alaska, as late as September 2, 1899 (Bishop); Morro Bay, California, November, 1891 (Nelson); Great Bear Lake, August 30, 1903 (Preble); near Cape Churchill, Hudson Bay, August 24, 1900 (Preble); Henley Harbor, Ungava, August 27, 1860 (Coues). Near Newport, R. I., a gunner secured 30 birds in eight years on dates ranging from August 26, 1867, to October 2, 1874 (Sturtevant). Barbuda, West Indies, November 12, 1903 (specimen in United States National Museum).

Eskimo Curlew. *Numenius borealis* (Forst.).

Breeding range.—The principal summer home of the Eskimo curlew was on the barren grounds of Mackenzie, from near the Arctic coast (MacFarlane) south to Point Lake (Richardson). Thence a few ranged west as far as Point Barrow (Murdoch), but no nests seem to have been found west of Mackenzie.

Winter range.—Most of the species wintered in the campos region of Argentina (Sclater and Hudson) and Patagonia, south at least to the Chubut Valley (Durnford). It has been taken once on the Falkland Islands (Abbott). It was rare in Chile, south to Chiloe (Philippi). At present there are no data to determine the northern limit in winter, but probably few if any wintered much north of Buenos Aires.

Migration route.—The curlew left the Barren Grounds in the fall and went southeast to Labrador (Coues), where they gorged themselves for several weeks and became extremely fat. Then they passed across the Gulf of St. Lawrence and struck out to sea heading for the Lesser Antilles, nearly 2,000 miles distant. Some flocks stopped for a few days at the Bermudas (Jardine), but if the weather was fair the larger number passed on, flying both day and night, and did not land during the whole trip. When storms interfered, the birds were sometimes driven out of their course and appeared in considerable numbers on the coast of Massachusetts (Mackay) and less often on Long Island (Giraud) and the New Jersey coast (Turnbull). The Eskimo curlew was absent, except as a straggler, from the whole coast of the United States south of New Jersey, from the Bahamas and from the Greater Antilles. In its southward flight it passed through the Lesser Antilles (Feilden) and along the eastern portion of Brazil (Pelzeln) to its winter home. Throughout the whole line of its fall migration it was unknown in spring, at which season it was traveling northward some thousands of miles farther west over the prairies of the Mississippi Valley. The exact route between its winter home and the United States is unknown, for along the whole 4,000 miles from Argentina to northern Mexico and southern Texas the species has been recorded only twice—once in Costa Rica (Zeledon) and once in Guatemala (Salvin). Its principal migration route in spring was a comparatively narrow belt crossing the prairies on both sides of the meridian of 97°. The course is well known from southern Texas (Merrill) to southern South Dakota (Agersborg) and thence data are wanting. There seem to be no records of the species from about latitude 44° in the Mississippi Valley until Great Slave Lake is reached, a thousand miles to the northward.

This curlew is unknown in the Rocky Mountain States or anywhere on the Pacific slope or coast south of Alaska, and the specimen taken April 8, 1892, at Lake Palomas, Chihuahua (specimen in United States National Museum), was far out of the usual course of the species. The species has been taken a few times in western Alaska, south to St. Michael (Nelson) and west to the Pribilof Islands (Palmer) and Bering Sea (specimen in United States National Museum). It has occurred accidentally several times in Europe and on the western coast of Greenland, north to Disco Bay (Winge).

Spring migration.—The Eskimo curlew arrived in Texas in March—Boerne, March 9, 1880 (Brown); Gainesville, average March 17, earliest March 7, 1884 (Ragsdale); and reached central Kansas about the middle of April—April 14, 1884 (Kellogg); April 13, 1885 (Kellogg). Most of the records in the central Mississippi Valley are in April. One of the latest and most northern is that of Coues, who says that he saw them in large flocks the second week in May, 1873, between Fort Randall and Yankton, S. Dak. Then there is no further news of them until they arrived at Fort Resolution, Mackenzie, May 27, 1860 (Kennicott); Fort Anderson, May 27, 1865 (MacFarlane); Point Barrow, May 20, 1882 (Murdoch).

Eggs were taken at Point Lake, Mackenzie, June 13, 1822 (Richardson), and on the Barren Grounds near Fort Anderson, June 13, 1863, June 16, 1864, and June 16, 1865 (MacFarlane).

Fall migration.—The Eskimo curlew started so early in August that by the middle of the month the old birds reached the eastern shores of Labrador (Coues). During the following two weeks they crossed the Gulf of St. Lawrence and made their long ocean flight and by the end of another fortnight they were at the winter home in Argentina (Sclater and Hudson). Dates of arrival along this course are: Indian Tickle Harbor, Labrador, August 16, 1860 (Coues); Houlton Harbor, Labrador, August 20, 1891 (Norton); Nantucket, Mass., average August 29, earliest August 18, 1898 (Mackay); Barbados, West Indies, August 27, 1886 (Manning); Amazon River, September 4, 1830 (Pelzeln); Concepcion, Argentina, September 9, 1880 (Barrows). Some dates of the last seen are: Fort Churchill, Keewatin, September 1, 1884 (Bell); Newfoundland, to end of September (Reeks); Saybrook, Conn., October 13, 1874 (Merriam); Barbados, West Indies, November 4, 1886 (Manning). Many curlews migrated south along the west coast of Hudson Bay, before they turned east to the Atlantic and some of these seem to have wandered occasionally southward and given rise to such records as Kingston, Ontario, October 10, 1873 (Fleming); Erie, Pa., September 17, 1889 (Sennett); and a few fall records around Lake Michigan.

The Eskimo curlew is rapidly approaching extinction, if indeed any still exist. In the early sixties MacFarlane found them breeding abundantly on the Barren Grounds near Fort Anderson, while Coues reports thousands passing south along the Labrador coast in the fall; in the early seventies Coues found them equally abundant passing north through South Dakota in the spring. Ten years later they were still common in their winter home in Argentina, and naturalists who visited the Labrador coast at this time record them as present in flocks but not in numbers as seen by Coues. By 1889 only a few flocks were seen, and within the next half dozen years the flights ceased. During the last fifteen years the species has been recorded only a few times and apparently only three times in the ten years previous to 1909: Tuckernuck Island, Massachusetts, eight birds August 24, 1897 (Mackay); Nantucket, Mass., two, August 18, 1898 (Mackay); northeastern coast of Labrador, about a dozen the fall of 1900 (Bigelow). The latest records are those of two birds shot August 27, 1908, at Newburyport, Mass. (Thayer), and one September 2, 1909, at Hog Island, Maine (Knight). The disappearance of the Eskimo curlew has given rise to much speculation as to the probable cause. A simple explanation is that during recent years, especially since 1880, its former winter home in Argentina has been settled and cultivated, while its spring feeding grounds in Nebraska and South Dakota have been converted into farm land.

[**European Curlew.** *Numenius arquatus* (Linn.).

This Eastern Hemisphere species breeds from Great Britain to southern Russia, the White Sea, and the Ural Mountains. It winters in Great Britain and occurs at this season from the Mediterranean to the south end of Africa.

It is probable that one specimen of this curlew was collected on Long Island in 1853—its only North American record.]

Whimbrel. *Numenius phæopus* (Linn.).

Though an Old World species, the whimbrel is a common visitor in Greenland (Schalow) and possibly breeds there. It breeds in Iceland, Scandinavia, and Russia, east to the Ural Mountains and north to the Arctic Circle. It winters on the coast and islands of tropical and southern Africa, and ranges at this season east to India and the Malay Peninsula. One was taken May 23, 1906, about latitude 43° N. and longitude 60° W., south of Sable Island, Nova Scotia (Brewster).

Bristle-thighed Curlew. *Numenius tahitiensis* (Gmel.).

The breeding range of this species has not yet been ascertained, but in Alaska it has been taken May 18, 1869, on the Kenai Peninsula (Bischoff); May 24, 1880, at St. Michael (Nelson); August 26, 1885, on the Kowak River (Townsend); and May 23, 1905, at the head of Nome River (Anthony). These dates would seem to indicate that the species nests in the northern part of its range.

The species is common on the Hawaiian Islands and occurs throughout the islands of the Pacific south to New Caledonia and from the Ladrones to the Marquesas and Paumota islands. The Pacific islands seem to be the winter home of the species, and on some of them it is quite common. It has been taken in the Phoenix group near the equator in June and July, and a few are known to remain all summer in Hawaii (Henshaw), but these apparently are nonbreeding birds.

Lapwing. *Vanellus vanellus* (Linn.).

Though an Old World species, the lapwing has been noted several times in Greenland on the west coast from Julianehaab to Godthaab, at various times from early December to the first of April (Schalow). It has been taken as a straggler at White Hills, Newfoundland, November 23, 1905 (Brewster); Halifax, Nova Scotia, March 17, 1897 (Piers); Merrick, Long Island, about December 26, 1883 (Dutcher); Meccox Bay, Long Island, fall of 1905 (Beebe); Hog Island, Bahamas, November, 1900 (Fleming); Barbados, 1886 (Cory).

The breeding range extends from Great Britain to Japan, from central Europe to the Arctic Circle, and from northern China to about latitude 55° in Siberia. The species winters from about the southern limit of the breeding range to northern Africa and southern China.

Dotterel. *Eudromias morinellus* (Linn.).

This is an accidental visitor to North America, the only record being that of one taken July 23, 1897, on King Island, Alaska (Stone). It breeds from Great Britain, southern Russia, and eastern Siberia north to the islands of the Arctic coast. It winters from southern Europe to equatorial Africa.

Black-bellied Plover. *Squatarola squatarola* (Linn.).

Breeding range.—This is a circumpolar species, but the places where it is known to breed are comparatively few. In North America it has been found breeding on the Melville Peninsula (Richardson), Boothia Felix (Ross), Franklin Bay (MacFarlane), and Point Barrow (Murdoch). In the Eastern Hemisphere it breeds on the Kolgnjef and Dolgoi islands of Russia and near the Taimyr Peninsula, Siberia, and probably breeds on the Liakoff Islands, Siberia, and near the south end of Nova Zembla Island.

Winter range.—The North American breeding birds pass south in winter to Chimbote and Tumbez, in northern Peru (Taczanowski), and to the Amazon River, Brazil (Pelzeln). The species is also found at this season through northern South America, the West Indies, Central America, and Mexico to the coast of South Carolina (Coues), occasionally North Carolina (Bishop), southern Texas (Sennett), and the coast of California north to Humboldt County (Townsend). It probably wintered formerly to the mouth of the Columbia (Suckley). The birds of Russia and Siberia winter from the Mediterranean, India, and southern China to southern Africa and Australia. The species is accidental in Hawaii (Henshaw).

Migration range.—The black-bellied plover has been taken several times on the west coast of Greenland north to Egedesminde, latitude 69° N. (Winge), but probably does not breed in that country. It is known only as a migrant along the east coast of Siberia, as at Plover Bay (Nelson) and on the Commander Islands (Stejneger).

Spring migration.—The species is a late and not common migrant on the Atlantic coast in the spring, and appears in New Jersey (Stone) and on Long Island in late April and early May; Montauk, N. Y., April 30, 1902 (Scott); Cape Cod, Massachusetts, average May 23, earliest April 18, 1894 (Mackay); Pictou, Nova Scotia, May 17, 1895 (Hickman). Nor is it common in the interior, where some dates of spring arrivals are: Near New Orleans, La., March 2, 1890 (Beyer); Sedalia, Mo., March 21, 1884 (Sampson); southern Ontario, average May 27, earliest May 22 (Fleming); Vermilion, S. Dak., May 3, 1884 (Agersborg); northern North Dakota, average May 8, earliest May 5, 1894 (Bowen); Reaburn, Manitoba, average May 19, earliest May 14, 1901 (Wemyss); Cheyenne, Wyo., average May 18, earliest May 11, 1884 (Bond); Indian Head, Saskatchewan, average May 14, earliest May 9, 1904 (Lang); Fort Chipewyan, Alberta, May 23, 1901 (Preble); Fort Resolution, Mackenzie, June 2, 1860 (Kennicott); Sitka, Alaska, May 6, 1869 (Bischoff); mouth of the Yukon, May 12; Dawson, Yukon, May 20, 1899 (Bishop); Point Barrow, Alaska, June 21, 1882 (Murdoch), and June 26, 1898 (Stone).

Some individuals remain late in the spring on the Atlantic coast and possibly some nonbreeders may remain the entire summer. In Florida they have been seen June 14, June 29, July 4, July 26, and

August 3 (Scott and Worthington). They have been seen in Jamaica in June (Field), and even off the coast of Venezuela they were common June 21–27, 1892 (Hartert). The last of the regular migrants do not leave the coast of Massachusetts until June—average June 6, latest June 15, 1886 (Cahoon); Western Egg Rock, Maine, June 24, 1895 (Knight); Toronto, Ontario, June 2 (Fleming); Corpus Christi, Tex., July 1, 1887 (Sennett).

Eggs were taken at Franklin Bay, Mackenzie, July 4, 1864, and July 8, 1865 (MacFarlane), but in each case the eggs were already partly incubated.

Fall migration.—The southward movement begins early in July, bringing a few individuals into the United States the latter part of that month—eastern Massachusetts, July 8 (Howe and Allen); Toronto, Ontario, July 23, 1890 (Fleming)—but the regular migration occurs in August: Cape Cod, Massachusetts, average August 17, earliest August 6 (Mackay); Long Island, New York, average August 6, earliest July 1, 1905 (Kobbe); Erie, Pa., August 1, 1890 (Todd); southern Wisconsin, August 10, 1872 (Kumlien and Hollister); southern British Columbia, August 15, 1903 (Brooks). The last were seen at Winter Island on the coast of Melville Peninsula August 17, 1821 (Greely), and the first flocks came along the Labrador coast August 15, 1860 (Coues). The species was unusually abundant on Prince Edward Island in 1892 from August 22 to September 14 (Mackay). Some dates of the last seen are: Point Barrow, Alaska, August 20, 1897 (Stone); Great Bear Lake, Mackenzie, September 5, 1903 (Preble); St. Michael, Alaska, September 16, 1899 (Bishop); southern British Columbia, October 23, 1888 (Brooks); Fort Collins, Colo., October 28, 1893 (Cooke); Lincoln, Nebr., October 21, 1899 (Wolcott); Ottawa, Ontario, average October 24, latest November 8, 1903 (White); Pictou, Nova Scotia, October 11, 1894 (Hickman); Cape Cod, Massachusetts, average October 21, latest November 14, 1887 (Cahoon)—accidental in December, 1872 (Mackay); Erie, Pa., November 10, 1894 (Todd); Long Island, New York, average October 15, latest November 7, 1905 (Latham).

European Golden Plover. *Charadrius apricarius* Linn.

The combined ranges of the three golden plovers complete the circumference of the globe in the vicinity of the Arctic Circle. In general it may be said that *apricarius* breeds in northern Europe and northwestern Siberia; *dominicus* in North America; and *fulvus* in eastern Siberia. The ranges of *apricarius* and *dominicus* meet on the west coast of Greenland; *dominicus* and *fulvus* join ranges in western Alaska; the dividing line in Siberia between *fulvus* and *apricarius* has not yet been determined.

The European golden plover breeds from Great Britain to western Siberia and south to central Europe. It winters from about the southern limit of the breeding range south to Beluchistan and northern Africa. This plover has been taken as a summer visitor to the east coast of Greenland (Helms), and at several places on the west coast from the southern end to Christianshaab about 69° latitude (Winge). It has not yet been found breeding in Greenland, though it has been taken there in midsummer (Helms).

Golden Plover. *Charadrius dominicus* Müll.

Breeding range.—The summer home of the golden plover extends from Whale Point at the northwest corner of Hudson Bay (Eifrig), west across the barren grounds to the mouth of the Anderson River (MacFarlane), and thence along the barren grounds of the coast of Alaska to Kotzebue Sound (Grinnell). It extends north in Franklin to include the islands, at least as far as latitude 77°. The bird is known to breed commonly on Banks Island (Armstrong), Prince Albert Island (Armstrong), Melville Island (Parry), and the islands at the north end of Wellington Channel (Belcher), and east to the eastern coast of Melville Peninsula (Parry). It probably does not breed in Greenland, though it occurs not uncommonly on the west coast to about latitude 73° (Walker). There are somewhat doubtful records of the species having been seen August 7, 1881, at Cape Baird, Lady Franklin Bay, 81° 30′ N. (Greely), and on July 12, 1872, at Thank God Harbor, Greenland, 81° 40′ (Davis). As the belt of tundra along the north coast of Alaska is comparatively narrow, the principal breeding grounds of the golden plover are between the mouth of the Mackenzie River and the Gulf of Boothia, north of the Arctic Circle.

Winter range.—The species ranges south on the Atlantic coast to Bahia Blanca, central Argentina (Barrows), and the center of abundance during the winter season is the pampas of Argentina (Sclater and Hudson) and Uruguay (Aplin), between the parallels of 34° and 36° S. Individuals remain during the winter as far north as Rio Janeiro, Brazil (Hapgood), on the coast and to Cuyaba, Matto Grosso (Pelzeln), in the interior. There is one record of the occurrence of the species (probably casual) in January at Nauta in northeastern Peru (Sharpe). The golden plover does not winter in the Lesser Antilles nor in that part of northeastern South America where it is most abundant in migration. It has been recorded as wintering at several places north of South America, but probably such of these records as are not errors represent accidental or unusual occurrences.

Migration range.—From the breeding grounds the golden plover go south and southeast to Labrador; then cross the Gulf of St. Lawrence and its islands to Nova Scotia, and from the southern coast of the latter fly directly across the ocean to the Lesser Antilles and the coast of northeastern South America. Sometimes when caught by a storm during this flight they seek the nearest land, appearing not infrequently at the Bermudas, Cape Cod, and Long Island. After a short stop in the Antilles and northern South America, they pass to the winter home in Argentina and remain there from September to March.

The return northward in spring is by a different route, the details of which are not yet determined. What is known is that they disappear from Argentina and shun the whole Atlantic coast from Brazil to Labrador. In March they appear in Guatemala and Texas; April finds them on the prairies of the Mississippi Valley; the first of May sees them crossing our northern boundary; and by the first week in June they reappear on their breeding grounds in the frozen north.

Various theories have been advanced to account for this strange migration course. The simplest explanation seems to be the application of the following, which may be laid down as the fundamental law underlying the choice of migration routes. Birds follow that route between the winter and summer homes that is the shortest and at the same time furnishes an abundant food supply. Applying this rule to the case of the golden plover, the following facts are apparent: The plover is a bird of treeless regions; it summers on the tundras and winters on the pampas; an enormous food supply especially palatable tempts it in the fall to Labrador and furnishes power for the long flight to South America. To attempt to return in spring by the same course would be suicidal, for at that season Labrador would furnish scant provender. The plover seeks the shortest treeless route overland, and alighting on the coast of Texas travels leisurely over the Mississippi Valley prairies, which are abundantly supplied with food, to the plains of the Saskatchewan and thence to the Arctic coast.

Spring migration.—The principal line of migration from the winter home northward through South America is not yet known; the species is said to be common in March and April in Peru (Sclater and Salvin) east of the mountains, but next to nothing is known regarding its appearance in the territory for a thousand miles to the northward. The species is practically unrecorded at all seasons of the year from Ecuador, Colombia, Panama, Nicaragua, and Honduras, and though a few have been noted in Costa Rica (Cherrie), Guatemala (Sclater and Salvin), and eastern Mexico (Sclater), in none of these countries have the great flocks been seen that are so characteristic of the fall flight in the Lesser Antilles and of the spring advance up the Mississippi Valley. Not until Texas is reached can the movements of the golden plover be definitely traced, and at no place between Peru and Texas has it ever been recorded as common. In fact, the records as they stand are what they should be if the plover escapes the forested regions of northern South America and Central America by a single flight of from 2,000 to 2,500 miles from the valleys of eastern Peru to the treeless prairies of Texas. The general time of appearance in the

United States and of passage to the summer home can be gathered from the following dates of arrival: Boerne, Tex., March 9, 1880 (Brown); Indianola, Tex., March 15, 1856 (Cassin); Gainesville, Tex., March 17, 1885 (Ragsdale); Caddo, Okla., March 12, 1884 (Cooke); near New Orleans, La., March 24, 1894 (Allison), April 2, 1881 (Langdon); Fayetteville, Ark., abundant March 20–31, 1883 (Harvey); central Missouri, average April 13, earliest April 11, 1903 (Bryant); Badger, Nebr., average April 8, earliest April 5, 1903 (Colt); Lebanon, Ill., March 17, 1876 (Jones); Tampico, Ill., average April 10, earliest March 31, 1885 (Brown); Terre Haute, Ind., March 23, 1888 (Evermann); Chicago, Ill., average April 16, earliest March 30, 1899 (Gault); central Iowa, average April 19, earliest April 12, 1883 (Williams); Heron Lake, Minnesota, average May 1 (Miller); central South Dakota, average April 30, earliest April 25, 1888 (Bishop); Larimore, N. Dak., average May 5, earliest May 2, 1895 (Eastgate); Aweme, Manitoba, average May 4, earliest April 23, 1905 (Criddle); Indian Head, Saskatchewan, May 9, 1904 (Lang); Fort Simpson, Mackenzie, May 26, 1860 (Ross), May 19, 1904 (Preble); Fort Reliance, Yukon, May 13 (Nelson); Point Barrow, Alaska, latitude 71° N., May 21, 1882 (Murdoch), May 24, 1883 (Murdoch), June 1, 1898 (Stone). The dates of arrival in the province of Franklin are: Igloolik, 69°, June 14, 1823 (Parry); Boothia Felix, 70°, June 4, 1830 (Ross), June 22, 1831 (Ross); Prince of Wales Strait, 73°, June 7, 1851 (Armstrong); Bay of Mercy, 74°, June 3, 1852 (Armstrong); Winter Harbor, 75°, June 2, 1820 (Parry); near Wellington Channel, 77°, June 2, 1853 (Belcher).

The latest dates recorded in the southern part of the winter range are March 12 (Aplin) and March 19 (Barrows); in the northern part of the winter home the species remains until April (Sclater and Salvin); at Chicago the average date of the last one seen is April 30, and the latest May 9, 1895 (Blackwelder). Some other late dates are: Near New Orleans, La., June 10, 1907 (Kopman); Lebanon, Ind., May 10, 1894 (Beasley); Lawrence, Kans., May 8, 1906 (Wetmore); White, S. Dak., May 27, 1889 (Partch); Aweme, Manitoba, average May 23, latest May 29, 1896 (Criddle); Fort Chipewyan, Alberta, June 1, 1893 (Russell). South of the latitude of Chicago the bulk of the spring shooting of golden plover is in April; from Iowa northward to Canada the spring shooting occurs chiefly during the first half of May.

During the spring migration the golden plover is almost entirely absent from the Atlantic coast. There are three spring records for Massachusetts (Mackay) and a few for Long Island (Giraud), the last of them many years ago. Probably most of the other scattered spring records east of the Alleghenies are errors of identification. The species is not common at any time of the year west of Texas, Nebraska, and Saskatchewan, and apparently is absent in spring from the whole region west of the Rocky Mountains.

Eggs were collected on the lower Anderson River, Mackenzie, June 24, 1863, June 22, 1864, and June 16, 1865 (MacFarlane); at Point Barrow, Alaska, June 22, 1882, and June 23, 1883 (Murdoch).

Fall migration.—The old birds start south in July, and those that are to make the flight from Nova Scotia to the Lesser Antilles occupy about a month in the trip from the breeding grounds to the southern coast of Nova Scotia. If fair weather prevails, the flocks of golden plover pass by the New England coast far out at sea, but severe storms are frequent at this season, and the birds are often driven to land. The average for twenty-eight years of the date of arrival of these storm-driven migrants at Nantucket, Mass., is August 25, earliest August 12, 1898 (Mackay); a still earlier date is August 7, 1852, at Plymouth, Mass. (Browne). Five times in these twenty-eight years birds were seen before August 20 (Mackay). The rule on Long Island is to expect the plover with the first storm occurring after August 28 (Lawrence). The first flocks are noted in the Bermudas during the last ten days of August (Reid), and about the same time the species arrives in the Lesser Antilles (Lawrence) and even on the coast of British Guiana (Quelch). A few golden plover reach Argentina the last week in August (Sclater and Hudson) and the species has been taken in Bolivia in August (Allen), but these early couriers are exceptional, and the main flocks arrive in September.

On the west side of Baffin Bay in 1820 the last was seen September 3 (Parry); in Nova Scotia the species sometimes remains until October (McKinlay). The average date of the last one seen at Nantucket, Mass., for ten years previous to 1890 is October 2, latest October 22, 1878 (Mackay); for the years since 1890 the average date of the last seen is September 23 (Mackay). Near Newport, R. I., a market hunter shot 386 golden plover during 1867 to 1874; the dates ranged from August 14, 1868, to October 24, 1874 (Sturtevant). On Long Island the dates of the earliest and latest recorded observations of the species are August 15 and November 10 (Chapman). In the Bermudas and the Lesser Antilles most of the birds leave in October, though some stragglers may be noted in November.

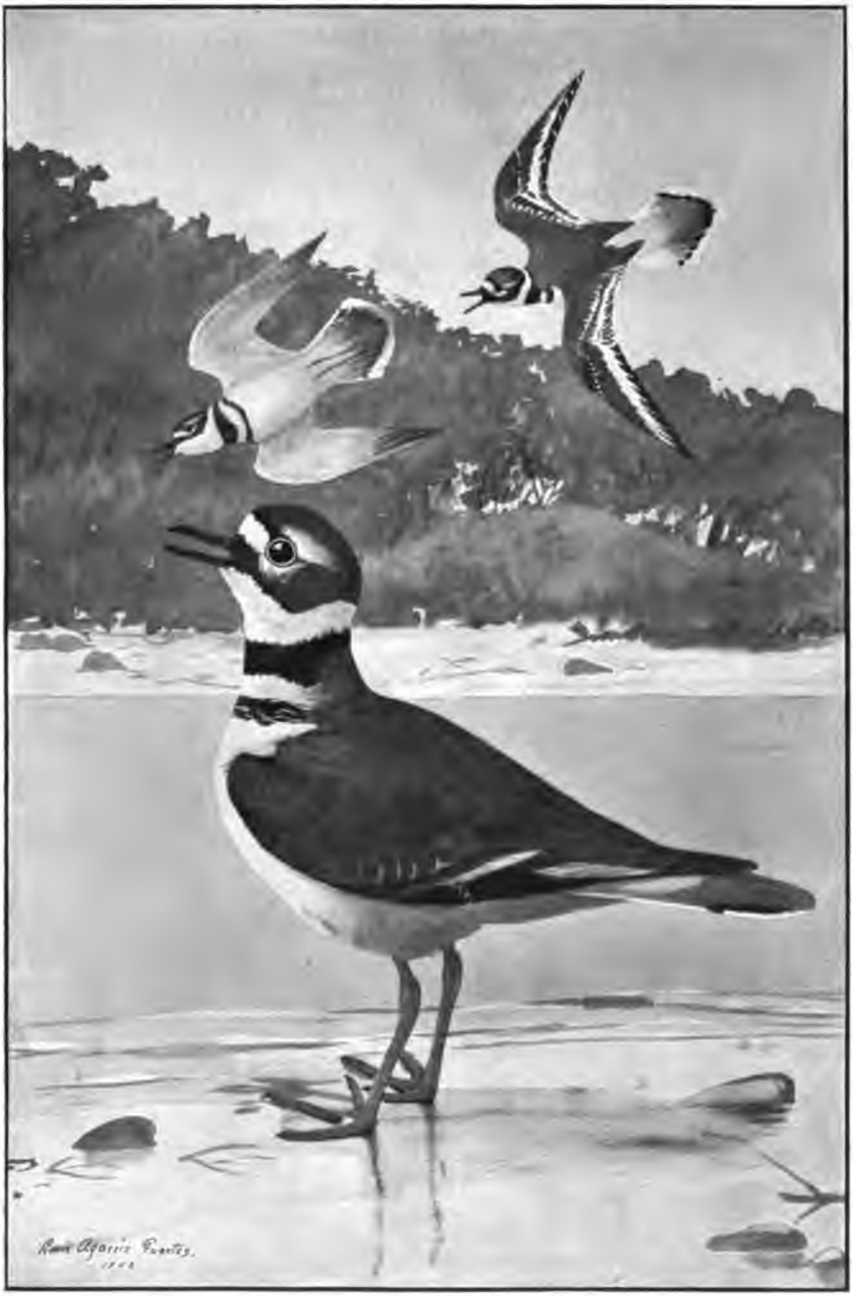
In the interior of New England the golden plover is rare in fall, though at times it is quite common on Lake Champlain. Throughout New York, Pennsylvania, and New Jersey it is usually very rare, but in 1880 and in several other years it has been common in those States. It has been seen at Erie, Pa., on dates ranging from August 20, 1896, to November 18, 1900 (Todd). South of New Jersey on the Atlantic coast, also in the Bahamas, the golden plover is almost unknown, and it is not common anywhere in the Greater Antilles west of St. Croix.

While the greater number of golden plover migrate across the Atlantic, a few pass south in the fall through the interior of North America. The first arrival from the north noted near Fort Churchill, Keewatin, in 1900, was on August 4 (Preble). Other dates of fall arrival in the interior are: Moose Factory, Ontario, September 8, 1860 (Drexler); Aweme, Manitoba, average September 9, earliest August 10, 1904 (Criddle); Lincoln, Nebr., September 22, 1900 (Wolcott); near Toronto, Ontario, August 31, 1891 (Nash), September 1, 1898 (Nash); Point Pelee, Ontario, September 15, 1905 (Swales), September 19, 1906 (Taverner); Chicago, Ill., average September 12, earliest September 10, 1898 (Gault); Bay St. Louis, Miss., September 26, 1899 (Allison); San José, Costa Rica, October 20, 1890 (Cherrie). Probably these Mississippi Valley fall birds are the ones that are fairly common in Peru from September to November (Sclater and Salvin) and that were noted in October at Arica, Chile (MacFarlane).

The form of the golden plover that breeds on the northern and northwestern coasts of Alaska does not seem to migrate along the western coast of Alaska, but passes in general east to Mackenzie. A few individuals migrate southeast and occur in the fall as rare stragglers on the Pacific slope: Sitka, Alaska, August 16, 1896 (Grinnell); Chilliwack, British Columbia, August 26, 1889 (Brooks); Port Townsend, Wash., September 9, 1897 (Fisher); Santa Cruz, Calif., October 22, 1888 (McGregor); San José del Cabo, Lower California, October 18, 1887 (Brewster).

The golden plover does not remain late in the north. The last seen on the breeding grounds at Point Barrow, Alaska, were noted August 28, 1882 (Murdoch), and August 20, 1897 (Stone). Some other dates of late occurrence are: Great Bear Lake, September 6, 1903 (Preble); Fort Simpson, September 10, 1860 (Ross); Edmonton, Alberta, September 23, 1894 (Loring); Indian Head, Saskatchewan, October 2, 1904 (Lang); Aweme, Manitoba, average October 14, latest October 16, 1901 (Criddle); near Fort Pierre, S. Dak., October 21, 1855 (Cassin); Fort Sherman, Idaho, abundant September 15–20, 1896 (Merrill); Newcastle, Colo., October 5, 1902 (Bishop); Lincoln, Nebr., November 14, 1899 (Wolcott); Lanesboro, Minn., November 2, 1889 (Hvoslef); southern Iowa, average October 27, latest November 9, 1895 (Currier); Chicago, Ill., average October 11, latest October 28, 1895 (Blackwelder); English Lake, Ind., November 9, 1891, November 15, 1892 (Butler); Ottawa, Ontario, October 31, 1906 (White); city of Quebec, Canada, November 10, 1890 (Dionne); San José, Costa Rica, December 15, 1890 (Cherrie).

The golden plover is one of the shorebirds that has diminished most markedly during the last twenty years. Formerly it was enormously abundant, and many are the accounts of the countless flocks that passed in an almost continuous stream across the Gulf of



KILLDEER (OXYECHUS VOCIFERUS).

St. Lawrence and out to sea. On the return up the Mississippi Valley also they were abundant. For the ten years 1895–1904 the numbers reported have been so small that the species seemed in imminent danger of extinction. During 1905 and 1906, however, the species was reported from quite a number of localities, indicating that at present the comparatively small number of individuals left are holding their own. The future of the American golden plover is in the hands of the sportsmen of the Mississippi Valley. During the breeding season the birds are out of reach of danger from mankind; through the winter their welfare is out of the control of the people of the United States; but in spring during their two thousand mile journey up the Mississippi Valley, for from six to eight weeks, great numbers are slaughtered, and as a result they have diminished to a small fraction of their former numbers. If the species is to hold its own spring shooting in the Mississippi Valley must be largely curtailed or entirely abolished.

Pacific Golden Plover. *Charadrius dominicus fulvus* Gmel.

The principal summer home of the Pacific golden plover is in Asia, where it breeds in northern Siberia east of the Yenisei River; it breeds also on the western coast of Alaska from near Bering Strait south to Bristol Bay. It winters on the Hawaiian Islands and in China and India and south to New Zealand and Australia. Early dates of arrival in Alaska are at Portage Bay, May 13, 1882 (Hartlaub); Kadiak Island, May 13, 1868 (Bischoff); Atka Island, May 17, 1879 (Turner). The usual time of arrival at the mouth of the Yukon is about the first of June, and the latest date in the fall is October 12 (Nelson).

Killdeer. *Oxyechus vociferus* (Linn.).

Breeding range.—The killdeer has one of the most extensive breeding ranges of the American shorebirds. It ranges north in summer to central Quebec (Merriam), northern Ontario (Todd), central Keewatin (Preble), southern Mackenzie (Preble), and to about latitude 53° in the interior of British Columbia. The killdeer was seen at Fort Churchill, Keewatin, and at Fort Resolution, Mackenzie, by parties of the Biological Survey, and these observations very materially extend its previously known northern range. The breeding range of the killdeer extends much farther south than that of other northern breeding shorebirds. The species breeds not only throughout the whole of the United States, but south to Cape St. Lucas, Lower California (Xantus), and to Rio Sestin, Durango (Miller). Killdeers occur in Newfoundland in the fall (Reeks), but are not known to breed on that island.

Winter range.—The winter range is much less extensive than the summer. Though there are records of the presence of the species in

Paraguay (Sharpe) and Chile (Salvin), it is probable that these represent casual occurrences and that regularly the species ranges to the Bermudas (Jardine), throughout the West Indies and the neighboring northern coast of Venezuela (Ernst), but not farther east or south on the Atlantic coast; while on the Pacific it regularly passes south to northwestern Peru (Sclater and Salvin) and the interior of Colombia and Medellin (Sclater and Salvin). The northern winter range extends regularly to North Carolina (Brimley), Tennessee (Gettys), central Texas (Brown), rarely southern Arizona (Mearns), and throughout most of the southern half of California (Fisher). Casual occurrences have been noted in Maryland (Stabler), Pennsylvania (Burns), and Rhode Island (Mearns). After the great storm of November, 1888, which carried large numbers of killdeer to the New England coast several weeks later than the usual time for their disappearance from that part of their range, many of these birds failed to undertake a second southward migration and remained on the coasts of Massachusetts (Torrey), New Hampshire (Chadbourne), and southwestern Maine (Brown). Most of them perished during the winter, but on the Massachusetts coast a few managed to endure. An occasional killdeer passes a mild winter in southern Ohio (Jones), southern Indiana (McAtee), or on the Pacific coast to Washington (Johnson).

Spring migration.—The killdeer is among the earliest migrants among shorebirds, and is not far behind the earliest migrating land birds. Its loud, piercing, oft-repeated calls make its identification easy, and many data have been accumulated concerning the time of its migrations. These begin in February in the northern part of the winter range, and during that month many crowd northward to the limit of unfrozen ground. Such birds arrive on the average near Asheville, N. C., February 22, earliest February 18, 1893 (Cairns); central Kentucky, February 25, earliest February 19, 1906 (Embody); Brookville, Ind., February 23, earliest February 15, 1890 (Butler). The early days of March find the killdeer in full migration far beyond its winter home, and its arrival has been noted as follows: Variety Mills, Va., average March 13, earliest March 2, 1888 (Micklem); White Sulphur Springs, W. Va., average March 9, earliest March 2 1891 (Surber); Washington, D. C., average March 18, earliest February 14, 1908 (Hollister); Waynesburg, Pa., average March 8, earliest February 24, 1891 (Jacobs); Berwyn, Pa., average March 14, earliest January 29, 1889 (Burns); Branchport, N. Y., average March 19, earliest March 1, 1890 (Burtch); Jewett City, Conn., average for twenty-one years March 17, earliest March 2, 1888 (Jennings); central Rhode Island, average March 19, earliest February 27, 1902. Even as far north as Rhode Island, the killdeer is so rare that a market gunner near Newport (Sturtevant) secured only three during eight years while shooting several thousand shorebirds.

There seems to be a section west of the Allegheny Mountains in which the killdeer arrives earlier than at corresponding latitudes either east or west. The average date of arrival at Waterloo, Ind., is March 5 (Link); Oberlin, Ohio, March 5 (Jones); Livonia, Mich., March 10 (Alexander); and Petersburg, Mich., March 10 (Trombly). Near there in Pennsylvania, on the western side of the mountains, the date of arrival at Waynesburg has already been given as March 8 (Jacobs). At the same latitude in Pennsylvania east of the mountains the killdeer arrives a week later, while to the westward of Indiana the retardation of migration is shown by the following dates of arrival: Central Missouri, average March 12, earliest February 4, 1890 (Bush); southern Iowa, average March 12, earliest March 2, 1906 (Davison); southern Wisconsin, average of thirty years March 15, earliest March 2, 1887 (Welman); Chicago, Ill., average of sixteen years March 21, earliest February 28, 1895 (Woodruff). Farther north in Ontario, as the killdeer nears the limit of its breeding range, the arrival is much delayed; southern Ontario is not reached on the average until March 23, earliest March 7, 1903 (Smith), while the average date at Ottawa, Ontario, is April 17, earliest March 18, 1894 (White). Dates of arrival farther west are: Manhattan, Kans., average March 8, earliest February 27, 1882 (Lantz); Onaga, Kans., average March 4, earliest February 23, 1891 (Crevecoeur); Syracuse, Nebr., average March 10, earliest February 26, 1902 (Hunter); central South Dakota, average March 24, earliest March 20, 1889 (Cheney); Lanesboro, Minn., average March 29, earliest March 13, 1889 (Hvoslef); Argusville, N. Dak., average April 7, earliest March 31, 1893 (Edwards); Larimore, N. Dak., average April 7, earliest April 3, 1893 (Eastgate); southern Manitoba, average April 5, earliest March 24, 1902 (Criddle); Qu'Appelle, Saskatchewan, average April 16, earliest April 8, 1903 (Wemyss); two seen June 25, 1903, at Fort Resolution, Mackenzie (Preble).

The advance in the Rocky Mountains is not so late comparatively as in most species: Cheyenne, Wyo., average March 21, earliest March 16, 1889 (Bond); Rathdrum, Idaho, average March 30, earliest February 19, 1902 (Danby); Terry, Mont., average April 6, earliest March 29, 1897 (Cameron); Big Sandy, Mont., average April 6, earliest April 3, 1904 (Coubeaux); Red Deer, Alberta, April 11, 1893 (Farley); Portland, Oreg., February 27, 1900 (Nicholas); Grays Harbor, Washington, February 16, 1892 (Lawrence); southern British Columbia, February 28, 1888 (Brooks). South of the breeding grounds the last was seen at San José, Costa Rica, March 12, 1890 (Cherrie), and at Sisal, Yucatan, May 9, 1865 (Schott).

The date of nesting seems to bear little relation to the latitude. Eggs have been taken at Cape St. Lucas, Lower California, May 9, 1860 (Xantus); Monterey, Calif., March, 1867 (Day and Spencer);

Variety Mills, Va., April 12, 1886 (Micklem); Laurel, Md., just hatching April 24, 1897; Erie, Pa., April 7, 1888 (Todd); Canandaigua, N.Y., April 23, 1879 (Howey); Bloomington, Ind., April 12, 1903 (McAtee); Kingston, Ontario, May 1, 1905 (Beaupre); Eagle Pass, Tex., March 18, 1884 (Negley); Corvallis, Oreg., downy young late April (Woodcock); Tacoma, Wash., April 14, 1908 (Bowles); Edmonton, Alberta, eggs May 19, 1897 (Macoun).

Fall migration.—The few records of fall arrival south of the breeding range show that the killdeer is one of the late migrants. It was noted in Porto Rico, October 18, 1899, and October 7, 1900 (Bowdish); San José, Costa Rica, October 15, 1891 (Cherrie); and on the coast of Peru, October 24, 1867 (Sclater and Salvin).

The last noted in southern British Columbia was November 28, 1888 (Brooks); Aweme, Manitoba, average September 23, latest September 30, 1901 (Criddle); Onaga, Kans., average October 22, latest November 8, 1896 (Crevecoeur); Lincoln, Nebr., latest November 18, 1900 (Wolcott); Delavan, Wis., November 6, 1894 (Hollister); southern Iowa, average November 10, latest December 25, 1886 (Houghton); Chicago, Ill., average October 21, latest November 13, 1885 (Holmes); southern Michigan, average November 1, latest November 13, 1891 (Alexander); Ottawa, Ontario, average September 11, latest October 16, 1905 (White); southern Ontario, average October 19, latest November 10, 1900 (Saunders); Wauseon, Ohio, average November 9, latest November 23, 1891 (Mikesel); Waterloo, Ind., average November 7, latest November 21, 1905 (Link); Montreal, Canada, September 1, 1895 (Wintle); Phillips, Me., October 24, 1905 (Sweet); Block Island, R. I., November 5, 1889 (Dodge); Branchport, N. Y., November 29, 1896 (Stone); Suffield, Conn., November 16, 1887 (Smith); Erie, Pa., November 26, 1891 (Todd); Berwyn, Pa., average November 3, latest November 22, 1886 (Burns); Bloomington, Ind., December 12, 1885 (McAtee); St. Louis, Mo., December 18, 1887 (Widmann).

[**Santo Domingo Killdeer.** *Oxyechus vociferus torquatus* (Linn.).

The Santo Domingo killdeer is the resident form of the West Indies, breeding in Cuba, the Isle of Pines, Jamaica, and Haiti, and probably also in Porto Rico.]

Semipalmated Plover. *Ægialitis semipalmata* (Bonap.).

Breeding range.—The present known summer home of the semipalmated plover extends north to Cumberland Sound (Kumlien), Melville Peninsula (Parry), Wellington Channel (Greely), and Melville Island (Parry). The occurrence of the species at these two latter places, latitude about 75° N., makes it probable that it occurs equally far north on the western side of Baffin Bay. It is common on the arctic coast of America as far west as the mouth of the Mackenzie (MacFarlane). Thence westward it seems to be rare on the northern coast of Alaska (Nelson), but is tolerably common in Kotzebue

Sound (Townsend). It seems to be more common in the middle Yukon Valley (Bishop) than on the coast.

This plover breeds south to Sable Island (Dodd); southern New Brunswick (Cheney); the Magdalen Islands (Brewster); southern James Bay (Todd); York Factory, in southern Keewatin (Preble); probably rarely in northern Manitoba (Macoun); on the Slave River of southern Mackenzie (Preble); Lake Marsh, southern Yukon (Bishop); to the mouth of the Yukon, Alaska (Dall and Bannister); and on the Queen Charlotte Islands, B. C. (Brooks).

Winter range.—The species winters on both coasts of South America—south to Port Desire, 48° S. (Seebohm), on the east coast, and to central Chile (Schalow) on the west; thence through northern South America, Central America, and the West Indies to the southern Bahamas (Bonhote), Florida (Worthington), the coast of Georgia (Helme), South Carolina (Kendall), Mississippi (Allison), and Louisiana (Beyer); on the Pacific coast of Mexico, north to southern Lower California (Brewster). In winter it is thus one of the most widely distributed of the shorebirds.

Migration range.—The species is a common migrant in eastern North America west to the eastern parts of Texas (Beckham), Nebraska (Wolcott), and Saskatchewan (Macoun). Thence over the plains and throughout the whole Rocky Mountain district it is almost unknown, but reappears on the Pacific Coast, and ranges west in migration to the central Aleutian Islands (McGregor), the Pribilof Islands (Prentiss), and even occasionally across Bering Strait to the coast of Siberia (Nelson).

Spring migration.—At least four-fifths of the dates on the spring migration of this species fall in May. This is true for the entire district between the winter and summer homes, and the dates indicate that the migration in the United States occurs chiefly between May 10 and June 1. An unusually early individual was taken April 7, 1875, at Erie, Pa. (Sennett). Other spring dates are: Magdalena Bay, Lower California, March 12, 1889 (Bryant); Monterey, Calif., April 17, 1903; Vancouver Island, British Columbia, April 28, 1894 (Kermode); Mount McKinley, Alaska, May 17, 1908 (Sheldon); Kowak River, Alaska, May 30, 1899 (Grinnell); Pea and Bodie islands, North Carolina, April 25, 1905 (Bishop); Lincoln, Nebr., April 27, 1900 (Wolcott); southern Ontario, average of six years May 18, earliest May 8, 1885 (Garnier); Melville Peninsula, May 31, 1882 (Parry); Wellington Channel, June 6, 1851 (Greely). The species was taken in Cuba as late as May 22, 1900 (Palmer and Riley); southern Florida, May 25, 1886 (Scott); from New Jersey to the Great Lakes it remains regularly to the first week in June—latest Oberlin, Ohio, June 17, 1904 (Jones); latest Worth, Ill., June 20, 1894 (Woodruff); and along the coast of Maine nonbreeders occur all summer (Knight).

Eggs have been taken at Grand Manan, New Brunswick, June 21, 1875 (Cheney); James Bay, June 18, 1896 (Macoun); Cape Fullerton, June 28, 1904 (Eifrig); Fort Anderson, June 11, 1863 (MacFarlane); Fort Yukon, Alaska, June 2, 1862 (Lockhart); Lake Marsh, Yukon, just hatched, July 2, 1899 (Bishop).

Fall migration.—At one of the most southern breeding places, near York Factory, Keewatin, in 1900, the most advanced young were still in the downy stage July 10 (Preble), and yet by this time the species is already in full fall migration, and the earliest individuals have appeared several hundred miles south of the breeding range: Toronto, Ontario, July 5, 1890 (Fleming); Rhode Island, July 6 (Howe and Sturtevant); Coronado de Terraba, Costa Rica, July 3, 1907 (Carriker); Margarita Island, off the coast of Venezuela, July 7, 1895 (Robinson). The regular fall migration is about a month later: Sitka, Alaska, common after July 25, 1896 (Grinnell); Prince Edward Island, average of three years August 13 (Bain); Long Island, New York, average of seven years August 6, earliest July 17, 1905 (Latham); Grenada, West Indies, August 24, 1881 (Wells); Santa Catarina, Brazil, August 4 (Sharpe).

Though most semipalmated plover migrate early, a few stay until freezing weather: Ottawa, Ontario, average of five years September 19, latest September 29, 1885 (White); Prince of Wales Sound, Ungava, latest September 25, 1886 (Payne); Prince Edward Island, average of three years, October 13 (Bain); Erie, Pa., rare after October 1, latest November 2, 1901 (Todd); Point Pelee, Ontario, October 29, 1905 (Taverner and Swales); Grinnell, Iowa, October 22, 1886 (Jones); Los Angeles County, Calif., October 17, 1894 (Grinnell).

Ringed Plover. *Ægialitis hiaticula* (Linn.).

Both coasts of Greenland are included in the breeding range of the ringed plover, from the southern end to Sabine Island (Scoresby) on the east coast and to McCormick Bay (Schalow) on the west. Across Smith Sound from this latter place and one degree farther north, at Buchanan Bay, Ellesmere Island, latitude 78° 48′ (Feilden) is the farthest north the species has been found in the Western Hemisphere, though north of Europe it has been taken at 83° latitude. On the American side it breeds south to Cumberland Sound (Kumlien); also south to central Europe and Turkestan, and east to the New Siberian Islands, and occurs casually east to the Chuckchi Peninsula. The winter is spent from the shores of the Mediterranean to southern Africa and rarely to northwestern India. It has wandered to Chile (Sharpe), and to Barbados, September 10, 1888 (Feilden). The first arrived at Cumberland Sound in 1878 about the middle of June (Kumlien).

Little Ringed Plover. *Ægialitis dubia* (Scop.).

The claim of the little ringed plover to a place among North American birds is rather slight. A specimen is supposed to have been taken on the coast of Alaska (Harting), and one is recorded from San Francisco, Calif. (Ridgway). In each case the bird was far from home, for the breeding grounds of the species are in southern Europe, central Asia, and north to about 60° latitude. The species winters in the northern half of Africa, and in Asia south to India, and the Malay Archipelago.

Piping Plover. *Ægialitis meloda* (Ord).

Breeding range.—The northern limit of the piping plover's breeding range is in Nova Scotia (Bryant), the Magdalen Islands in the Gulf of St. Lawrence (Bishop), southern Ontario (Saunders), central Manitoba (Bendire), southern Saskatchewan (Macoun), and probably southwestern Keewatin (King). It is very local in its distribution during the breeding season, and is unknown over most of the district mentioned above. Formerly it nested on the coast of Virginia at Cobbs Island (Kirkwood), and was fairly common as a breeder on the New Jersey coast (Scott). Now it is rare as a breeder anywhere on the Atlantic coast south of Nova Scotia, though still nesting at a few localities south to southern New Jersey (Stone). In the interior it nests as far south as Erie, Pa. (Todd); the lake shore in northern Ohio (Jones); near Lake Michigan in northwestern Indiana (Woodruff); and west to central Nebraska (Bruner, Wolcott, and Swenk).

Winter range.—The coast of Texas (Sennett) and the coasts of Florida (Scott) and Georgia (Worthington) constitute the principal winter home of this species. Indeed, it is probable that records at other places represent stragglers. The West Indies are commonly included in the winter range, but the species seems to be only casual in migration south of the United States. It was taken once in Porto Rico in August (Gundlach); Jamaica in November (Gosse); a few in Cuba in April of a single year (Gundlach); several on three islands of the Bahamas in May (Bangs) and July (Bonhite); three individuals in the Bermudas in the fall (Reid). It has occurred occasionally on the New Jersey coast in winter (Stone).

Spring migration.—Dates of spring arrival are very irregular. The average date on Long Island, New York, is April 7; earliest March 24, 1884 (Dutcher); eastern Massachusetts, average April 12, earliest March 26, 1893 (Mackay); southern Ontario, average May 16, earliest May 1, 1891 (Fleming). Some other dates of arrival are: Cumberland, Ga., March 10, 1902 (Helme); near Newport, R. I., March 24, 1903 (King); Erie, Pa., April 16, 1900 (Todd); Oberlin, Ohio, May 13, 1907 (Jones); Sioux City, Iowa, May 8, 1904 (Rich); Gibbon, Nebr., May 4, 1888 (Thatcher); Indian Head, Saskatchewan, May 16, 1892 (Macoun). Thus, in general, migration up the Mississippi Valley is much later than at corresponding latitudes on the

Atlantic coast. Stragglers were noted at Cheyenne, Wyo., May 30, 1892 (Bond), Julesburg, Colo., May 17, 1899 (Dawson), and Natashquan, Labrador, May 31, 1909 (Townsend and Bent).

Eggs have been taken at Big Charity Island, Michigan, May 20, 1903 (Arnold); Erie, Pa., May 24, 1900 (Todd); Long Beach, New Jersey, June 12, 1877 (Scott); Magdalen Island, June 16, 1897; Cedar Point, Ohio, June 26, 1903 (Jones); Miller, Ind., June 13, 1905 (Butler); Miner County, S. Dak., June 5, 1891 (Patton); near Indian Head, Saskatchewan, June 18, 1892 (Macoun). Downy young were taken July 21, 1906, at Big Stick Lake, southwestern Saskatchewan (Bent).

Fall migration.—The first was seen on the coast of North Carolina July 14, 1904 (Bishop); and at Fernandina, Fla., August 3, 1906 (Worthington). It was taken at Corpus Christi, Tex., all through July, 1887 (Sennett), but these may have been nonbreeders that summered on the coast. In general the species migrates so early that it is seldom found north of its winter home after August. Late dates are: Long Island, New York, August 30, 1889 (Scott); eastern Massachusetts, August 26, 1888 (Miller); Erie, Pa., September 26, 1902 (Todd).

Snowy Plover. *Ægialitis nivosa* Cass.

Breeding range.—The sea coasts and the shores of the larger lakes of western United States constitute the principal breeding grounds of the snowy plover. The species nests at least as far north as Pescadero, Calif. (Willard); Humboldt River, Nevada (Hanna); Salt Lake, Utah (Ridgway); Comanche County, Kans. (Goss); and on the coast of Texas (Sennett). It is extremely local in the interior. It breeds south at least to Corpus Christi, Tex. (Sennett), and probably along the northern third of the western coast of Lower California (Belding).

Winter range.—It winters in Chile south at least to Calbuco, latitude 41° S. (Schalow), and thence north in Peru (Sclater and Salvin), Guatemala (Salvin), and Mexico (Belding) to the coast of California at Santa Barbara (Keck). On the Atlantic side it winters as far north as Aransas Bay, Texas (Sennett).

Migration range.—Outside of the regular winter and summer homes, the species has been taken once in Brazil (specimen in United States National Museum); Margarita Island, off the coast of Venezuela, July 2, 1895 (Robinson); Guantanamo, Cuba, July, 1858 (Gundlach); Long Island, Bahamas, July 16, 1903 (Riley); Celestun, Yucatan, April 12, 1865 (Schott); Whitfield, Fla., May 5, 1903 (Worthington); Bay St. Louis, Miss., September 19–20, 1899 (Allison); Toronto, Ontario, twice (Fleming); Lincoln, Nebr., May 17, 1903 (Swenk); Cheyenne, Wyo., once (Bond); Newport, Oreg., March 24, 1906 (Shaw); Grays Harbor, Washington, September 3, 1899 (Dawson).

Spring migration.—The snowy plover was seen in Comanche County, Kans., May 12, 1887 (Goss), and at San Francisco, Calif., April 8, 1857 (Hepburn). The species has been taken at Cavanche, Chile, in May (Schalow), and at Coquimbo, Chile, in June (Sharpe). It may prove to be resident in Chile.

Eggs have been taken in Los Angeles County, Calif., April 25, 1899 (Robertson), and young, May 1, 1897 (Grinnell); also eggs at Santa Cruz, Calif., April 16, 1873 (Cooper). In southern Kansas the eggs are laid in late May (Goss).

Fall migration.—Fall migrants have been recorded in September from Guatemala (Salvin), and in October from the southern limit of the range in Chile (Schalow). The species has been taken at San Francisco as late as November 1, 1898 (Hornung).

Mongolian Plover. *Ægialitis mongola* (Pall.).

In the summer of 1849 Captain Moore of the *Plover* in his search for Sir John Franklin touched at the Choris Peninsula, Alaska, and while there secured two specimens of the Mongolian plover—the first and only individuals ever taken in North America. The breeding range of the species is on the opposite side of Bering Sea, on the Commander Islands, and in northeastern Siberia. It migrates through Japan and China, and winters from the Philippines to Australia.

[**Azara Ring Plover.** *Ægialitis collaris* (Vieill.).

The Azara ring plover is the only true shorebird found in Central America that does not range north to the United States. It has a wide distribution in South America, south to Argentina, extends north to southern Mexico, and has been taken once on Grenada, West Indies.]

Wilson Plover. *Ochthodromus wilsonius* (Ord).

Breeding range.—The Wilson plover is found in summer throughout the northern Bahamas (Bonhote) and along the Gulf coast of the United States from Florida (Scott) to Texas (Merrill), and breeds along the Atlantic coast at the present time as far north as the islands off the southeastern coast of Virginia (Dutcher); many years ago it bred occasionally on the New Jersey coast (Wilson). The summer status of the species on the Pacific coast of Lower California is not yet definitely settled. It was found common at Abreojos Point, June 17, 1897 (Kaeding), but whether or not it was breeding was not determined.

Winter range.—The winter range is not known with certainty, because the West Indies are occupied by a resident subspecies, *rufinuchus*, and sufficient material has not yet been accumulated to determine the relative areas occupied by the two forms in winter. The northern form winters as far north as southern Florida—formerly northern Florida (Scott); the coast of southern Texas (Merrill); Guaymas, Sonora (Nelson); and La Paz, Lower California (Belding). Thence it ranges south to the Pacific coast of Guatemala (Salvin).

Spring migration.—Dates of arrival on the Atlantic coast are: Amelia Island, Florida, April 2, 1906 (Worthington); Darien, Ga., March 19, 1890 (Worthington); Cumberland Island, Georgia, March 18, 1902 (Helme); Frogmore, S. C., March 26, 1886, and March 20, 1888 (Hoxie); Fort Macon, N. C., April 15, 1869 (Coues). The species has wandered north on the coast several times to Long Island (Dutcher), once to Connecticut (Purdie), twice to Massachusetts (Townsend), and even to Nova Scotia (Goss). The only record for the Pacific coast of the United States is that of the single bird taken June 29, 1894, at Pacific Beach, California (Ingersoll).

Eggs have been taken at Sarasota Bay, Florida, April 8 (Moore); coast of Georgia, April 29 (Bailey); Corpus Christi, Tex., April 25 (Chapman); Cobbs Island, Virginia, May 7 (Oates).

[**Rufous-naped Plover.** *Ochthodromus wilsonius rufinuchus* (Ridgw.).

The principal home of the subspecies rufous-naped plover is the Greater Antilles, whence it spreads to the neighboring coasts of British Honduras and Guatemala; probably also to Yucatan. It breeds also in northern South America on the coast of Colombia, Venezuela, and Guiana. While some individuals remain all the year on the breeding grounds, others migrate a short distance to several of the islands of the Lesser Antilles and to Brazil as far south as Bahia. It is probably this form that occurs on the coast of Ecuador and Peru, but from lack of specimens this point is not settled.]

Mountain Plover. *Podasocys montanus* (Towns.).

Breeding range.—The mountain plover seems to be confined in summer to the United States, but closely approaches the boundaries, both north and south. In 1874 it was found breeding and not uncommon on the Frenchman River in Montana (Coues), not far from the Canadian boundary, and on Milk River, Montana (Coues), right at the line, but so far has not been recorded anywhere in Canada. It breeds south to northern New Mexico (Henshaw); east to northwestern Texas (Bailey), western Kansas (Fisher), and western Nebraska (Bruner), west to Sun River, Montana (Dutcher), Fort Bridger, Wyo. (Drexler), Del Norte, Colo. (Hill and Orth), and San Miguel County, New Mexico (Mitchell).

Winter range.—This species winters from northern California (Cooper), southern Arizona (Osgood), and San Antonio, Tex. (Beckham), south to Zacatecas, Mexico (Sharpe), and La Paz, Lower California (Sharpe). It is one of the few species that winters farther west than it breeds.

Migration range.—The more eastern individuals of this species probably follow the usual north and south migration route, keeping to the plains east of the foothills of the Rocky Mountains, but some of the more western individuals take a very peculiar course in migration. The species is a tolerably common migrant at Marysville in northern California (Belding), arriving in November. Whence come these November birds? The nearest point of the breeding range is northwestern Montana in the vicinity of Great Falls (Williams). To reach Marysville from Great Falls the plover must pass through

Idaho and either Oregon or Nevada, but in these three States it is unknown, and seems not to be recorded from Utah. So the birds that visit California are separated from the nearest known habitat of the species by a zone about 600 miles wide and containing two ranges of high mountains.

Spring migration.—The mountain plover is among the early migrant shorebirds. It arrived on the average at Beloit, Colo., March 26, earliest March 23, 1890 (Hoskins); Loveland, Colo., March 18, 1887 (Smith).

Eggs have been taken at Fort Lyon, Colo., June 9, 1886 (Thorne); San Luis Valley, Colo., June 10, 1873 (Henshaw); young just hatched at Terry, Mont., June 15, 1898 (Cameron); young at Colby, Kans., June 28, 1893 (Fisher); eggs near North Platte, Nebr., July 8, 1859 (Suckley).

Fall migration.—The first was seen at Corpus Christi, Tex., July 25, 1887 (Sennett); Pecos City, Tex., August 1, 1903 (Ligon). Quite a party of them was seen at James Island, Florida, July 20 to August 1, 1901 (Williams), but they were probably only stragglers. The last one noted in 1890 at Beloit, Colo., was on October 15 (Hoskins).

Surf Bird. *Aphriza virgata* (Gmel.).

The breeding range of the surf bird is unknown, for the bird has never been encountered in its summer home. It goes north along the Pacific coast of the United States in spring, and has been traced all along the coast to the Kowak River, Alaska, where it arrived May 29, 1899 (Grinnell). Then it disappears and is not seen again until on its way south the latter part of July. The natives say it breeds on the mountains a few miles back from the coast.

The surf bird winters in Chile, as far south as the Strait of Magellan (Sharpe), and is known in migration on the coasts of Peru (Tschudi), Ecuador (Hartert), Mexico (Xantus), and Lower California (Kaeding). It arrived at Newport, Oreg., April 25, 1895; April 27, 1897; May 3, 1899; April 27, 1900; average of the four years April 28 (Bretherton). Agreeing well with this date is its appearance at San Geronimo Island, Lower California, March 15, 1897 (Kaeding); and the date already given of May 29 at Kowak River, Alaska (Grinnell). An extra early date is March 8, 1859, at Puget Sound, Washington (Kennerly). The latest recorded date at the Strait of Magellan is March 3, 1879 (Sharpe); the species was common at Abreojos Point, Lower California, April 19, 1897 (Kaeding); a belated bird was taken on the Farallon Islands, Calif., June 3, 1903 (Kaeding). Several appeared in fall migration at Sitka, Alaska, July 21 (Grinnell); Newport, Oreg., July 24, 1900 (Bretherton); Monterey Bay, Calif., August 3, 1894 (Loomis); Vaqueria, Ecuador, September 16, 1901 (Hartert). The species has been noted at St. Michael, Alaska, until the first of October (Nelson), and at Berkeley, Calif., as late as October 24, 1888 (Palmer).

Turnstone. *Arenaria interpres* (Linn.).

Breeding range.—The turnstone inhabits nearly the whole of the Eastern Hemisphere and a small part of the Western. It breeds along the whole Arctic coast of Europe and Asia and south to Japan and the islands in the Baltic Sea. It ranges eastward across Bering Strait at least to Point Barrow, Alaska (Stone), and breeds south to the mouth of the Yukon (Nelson) and on the islands of St. Lawrence (Nelson) and St. Matthew (Elliott) in Bering Sea. Its range to the northeastward in North America has not yet been definitely settled. Two specimens from the west coast of central Greenland have been identified by W. Palmer as *interpres.* No specimens were examined by him from any point between Greenland and the Anderson River, Mackenzie; the specimens from this latter place are certainly *morinella.* Where the dividing line between the two forms runs is not certain, but since the birds of eastern Ungava are *morinella,* it is probable that this is the form occurring on the islands near the Arctic coast of North America and equally probable that the records on the islands northwest of Greenland should be referred to *interpres.* The species has been recorded along the whole west coast of Greenland, and was found breeding at Disco Bay (Kumlien) and on the eastern and northern coasts of Ellesmere Island almost to latitude 83° (Feilden). The turnstone, therefore, is one of the most northern breeding of all birds. On the eastern coast of Greenland it ranges at least as far north as Sabine Island, latitude 74° (Winge).

Winter range.—The species winters on the coasts of nearly the whole of the Eastern Hemisphere from Europe and Asia to southern Africa, Australia, and the islands of the Pacific, Indian, and eastern Atlantic oceans.

Spring migration.—The species arrived in the Aleutians at Unalaska May 19, 1890 (Palmer). As it winters in Hawaii (Henshaw), and is not known on the coast of the mainland south of Alaska, it is practically certain that these Unalaska birds make the journey of 2,000 miles in a single flight from Hawaii to the Aleutians. Other dates of spring arrival are: Mouth of the Yukon, May 19, 1879 (Nelson); Nulato, Alaska, May 23, 1868 (Dall); Point Barrow, Alaska, June 12, 1882 (Murdoch), June 12, 1883 (Murdoch), and May 29, 1898 (Stone). The dates of arrival northwest of Greenland are May 27, 1876, at Cape Henry (Hart), and June 2, 1883, at Cape Baird (Greely), each near latitude 82°.

Eggs were taken July 30, 1876, at Discovery Bay, Ellesmere Island, 81° 40′ N. (Hart), and young were already on the wing July 9, 1883, at Fort Conger (Greely), a few miles distant. Downy young were taken June 4, 1898, at Point Barrow, Alaska (Stone).

Fall migration.—The first arrived on the Pribilof Islands July 2 (Elliott), and after the middle of the month were abundant. The last ones noted were: Depot Point, Ellesmere Island, latitude 82° 45′ N., September 11, 1875 (Feilden); Point Barrow, Alaska, August 29, 1882 (Murdoch), and September 4, 1897 (Stone); Nushagak, Alaska, September 21, 1902 (Osgood). A specimen is reported taken September 8, 1904, at Pacific Beach, Calif. (Bishop), and one September 8, 1892, on Monomoy Island, Massachusetts (Bishop).

Ruddy Turnstone. *Arenaria interpres morinella* (Linn.).

Breeding range.—Undoubted breeding records of the ruddy turnstone are very rare. It nested on the Lower Anderson and Franklin Bay (MacFarlane), and specimens of the breeding birds have been identified as *morinella*. Some form of the turnstone, probably *morinella*, breeds on Melville Island (Sabine), on Melville Peninsula (Parry), and at Bellot Strait (Walker), but its identity has yet to be determined by the examination of specimens.

Winter range.—The turnstone of the Western Hemisphere ranges south in winter to central Chile—at least to Talcahuano (Sharpe) and probably to Valdivia (Boeck)—and to Sao Paulo in Brazil (Ihering). It winters on the coasts of northern South America, in the West Indies, Central America, Mexico, and north to the coast of South Carolina (Coues), Louisiana (Beyer), Texas (Merrill), and in California at least as far north as San Francisco (Mailliard).

Spring migration.—The turnstone, notwithstanding it winters so far north, is a late migrant. The probable explanation is that its breeding grounds in the far north are not ready for occupancy until nearly midsummer. It was seen May 7, 1906, on Pea and Bodie islands, North Carolina (Bishop). The average date of arrival on Long Island, New York, is May 16, earliest May 12, 1897 (Scott); eastern Massachusetts, May 5, earliest May 1, 1892 (Mackay); Erie, Pa., May 24, 1893 (Todd). It appears to be rare in spring north of Maine on the Atlantic coast.

The species is rare in the interior of the United States, but has been noted a few times in nearly every State east of the Rocky Mountains. Some dates of arrival are: Starke County, Ind., May 20, 1888 (Butler); Oberlin, Ohio, May 16, 1901 (Jones); southern Ontario, average May 27, earliest May 24, 1900 (Nash); Leech Lake, Minn., May 24, 1903 (Currier); Indian Head, Saskatchewan, May 15, 1892 (Macoun); Fort Chipewyan, Alberta, May 25, 1901 (Preble); Fort Resolution, Mackenzie, June 1, 1860 (Kennicott); Fort Simpson, Mackenzie, May 29, 1904 (Preble); Fort Anderson, Mackenzie, June 10, 1864 (MacFarlane); Winter Island, Melville Peninsula, June 14, 1822 (Richardson).

It was found off the coast of Venezuela, July 2, 1892 (Hartert), July 7, 1895 (Robinson), and early July, 1901 (Clark). A few are said to remain all summer on Carriacou Island, West Indies (Wells).

The migrant birds remain in numbers far south of the breeding grounds until early June: Jamaica, June 12, 1863 (Field); Arcos Keys, Yucatan, June 6, 1900 (Nelson and Goldman); Key West, Fla., June 14, 1888 (Scott); Long Island, New York, average June 4, latest June 9, 1905 (Latham); Toronto, Ontario, June 17, 1894 (Fleming).

Fall migration.—The southward movement must begin in July, for by early August migrants have appeared over much of the coasts of the United States. Some dates of fall arrival are: Monomoy Island, Massachusetts, July 27, 1886 (Cahoon); Long Island, New York, average August 5, earliest July 27, 1892 (Scott); Monterey, Calif., July 18, 1892 (Loomis); Fort Churchill, Keewatin, July 30, 1900 (Preble); common at Corpus Christi, Tex., after July 1, 1887 (Sennett); Toronto, Ontario, July 30, 1898 (Nash); Henley Harbor, Ungava, August 20, 1860 (Coues); Mingan Island, Gulf of St. Lawrence, August 16, 1887 (Palmer); Montreal, Canada, August 17, 1891 (Wintle); Erie, Pa., August 24, 1889 (Sennett); Punta Rassa, Fla., August 2, 1886 (Scott); San Mateo, Tehuantepec, August 9, 1869 (Sumichrast); Jamaica, August 13, 1863 (March); Bermudas, August 3, 1874 (Reid); Talcahuano, Chile, September 9, 1879 (Sharpe). Dates of the last seen are: York Factory, August 26, 1900 (Preble); eastern Massachusetts, October 9, 1889 (Miller); Erie, Pa., September 25, 1900 (Todd); Long Island, New York, September 20, 1889 (Scott), accidental November 24, 1887 (Scott).

Black Turnstone. *Arenaria melanocephala* (Vig.).

Breeding range.—The black turnstone breeds commonly on the coast of Alaska near the mouth of the Yukon (Nelson) and up the Yukon as far as Nulato (Dall and Bannister). It breeds less commonly north to Kotzebue Sound (Townsend) and south to Nushagak (McKay). It has been seen on the eastern side of Bering Strait nearly to Point Barrow, Alaska (Nelson), and on the western side to Herald Island (Nelson), off the northern coast of Siberia, but it is not yet known to breed in either of these localities.

Winter range.—The greater number winter on the coast of Lower California, south to Magdalena Bay (Anthony). The species is not rare in winter on the California coast as far north as San Francisco (Mailliard), and a few have been known to winter at the Strait of Juan de Fuca (Suckley).. It may winter occasionally even in southeastern Alaska, for the National Museum has a specimen collected February 2, 1897, at Howkan Island, Alaska (Cantwell).

Spring migration.—The species arrived at St. Michael, Alaska, about the middle of May (Nelson) and at Nulato, Alaska, May 16, 1867, and May 23, 1868 (Dall and Bannister).

Fall migration.—The black turnstone occurs on the Pacific coast from British Columbia (Kermode) to southern California throughout the entire summer, but is not known to breed (Grinnell). The presence of these nonbreeding birds prevents accurate observations on the arrival of the first migrants from the north, but it seems probable that early in July some appear on the coast of central California, and the species was seen August 6, 1902, on the Coronados Islands, Lower California (Grinnell and Daggett). The last leave the delta of the Yukon about the middle of September (Nelson) and Nushagak, Alaska, September 22, 1902 (Osgood).

European Oyster-catcher. *Hæmatopus ostralegus* Linn.

The southwestern coast of Greenland has been visited several times by the European oyster-catcher, once as far north as Godthaab, latitude 64° (Winge). It is not certainly known to breed there, but its breeding range extends from Iceland and western Europe to Turkestan and from southern Europe to the Arctic coast. It winters from central Europe to central Africa and to western India.

Oyster-catcher. *Hæmatopus palliatus* Temm.

The oyster-catcher ranges south to Santa Catharina, southern Brazil (Sharpe), and to Arauco in central Chile (Sharpe). It occurs throughout most of the West Indies and Central America and along both coasts of Mexico—on the west coast north to the Tres Marias (Nelson). On the Atlantic coast it is resident as far north as South Carolina (Coues), and formerly was common on the Virginia coast (Bailey), and bred at Great Egg Harbor, New Jersey (Wilson). There are a few records for the coast of Massachusetts (Brewer) and one at Grand Manan, New Brunswick (Boardman). At the present time it is rare or accidental north of Virginia, though a flock of about 20 was seen July 20, 1907, at Digby, Nova Scotia, by W. H. Osgood, of the Biological Survey. It is still resident on the coasts of Louisiana and Texas.

It breeds throughout most of its regular range and probably most individuals are nonmigratory. The few that migrate along the southern Atlantic coast perform their short migrations principally in March. Eggs were taken at Corpus Christi, Tex., in 1882, April 6 to 27 (Goss). Eggs are recorded in Florida from April 10 to May 6; and they have been collected on the islands of the Virginia coast from May 3 to July 12.

Frazar Oyster-catcher. *Hæmatopus frazari* Brewst.

The Frazar oyster-catcher is apparently nonmigratory, and is the common breeding bird of both coasts of southern Lower California, whence it ranges along the whole west coast of the peninsula and north to San Diego (Cooper), the coast of Ventura County (Evermann), and the Santa Barbara Islands (Cooper), casual on the coast of Sinaloa, Mexico (Nelson and Goldman). In the northern part of its range it is not so numerous as *bachmani*, whose range overlaps that of *frazari* for about a thousand miles from Ventura County, Calif., to Abreojos Point, Lower California (Kaeding).

Black Oyster-catcher. *Hæmatopus bachmani* Aud.

The coast of western North America is the home of the black oyster-catcher, and it breeds locally throughout its range from Abreojos Point, Lower California (Kaeding), north to Prince William Sound, Alaska (Grinnell), and west to Attu Island (Turner) at the western end of the Aleutian chain. It winters from the coast of southern British Columbia (Fannin) southward. The short migration is performed during May, and the eggs are deposited at the northern end of the range from the middle to the latter part of June. This is also the time at which eggs are most commonly found at the extreme southern end of the summer home. Downy young were taken June 17, 1900, on Queen Charlotte Islands, British Columbia (Osgood).

[Stone Curlew. *Œdicnemus bistriatus* (Wagler).

The stone curlew is somewhat generally distributed throughout the lower portions of Central America from Panama to southern Mexico, and also ranges into South America north of the Amazon. It is nonmigratory.]

Mexican Jacana. *Jacana spinosa* (Linn.).

The Mexican jacana was described originally from Cartagena, Colombia, and as that remains still the only record for the country, the ascription to this locality was probably an error. The species is known from Divala, Panama (Bangs), and thence north on the Pacific side to Mazatlan, Mexico (Lawrence), and on the Gulf side to the mouth of the Rio Grande (Merrill). It is recorded from Porto Rico (Gundlach), Haiti (Ritter), Jamaica (Denny), and Cuba (Vigors)—rare in the first three and common in Cuba. One was taken October, 1899, at Lake Okeechobee, Florida (Mearns)—first record for the State. The species is resident throughout its regular range and breeds for about half the year from March to September.

[Black Jacana. *Jacana nigra* (Gmel.).

The black jacana is a nonmigratory species inhabiting northern South America and occurring in southern Panama.]

[Colombian Jacana. *Jacana melanopygia* (Sclater).

A nonmigratory South American species found principally in Colombia, but extending north to Panama.]

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BIOLOGICAL SURVEY—BULLETIN No. 36

HENRY W. HENSHAW, *Chief*

JAN 13

RAISING DEER AND OTHER LARGE GAME ANIMALS IN THE UNITED STATES

BY

DAVID E. LANTZ
Assistant, Biological Survey

WASHINGTON
GOVERNMENT PRINTING OFFICE
1910

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey,
Washington, D. C., Oct. 4, 1910.

Sir: I have the honor to transmit herewith, as Bulletin No. 36 of the Biological Survey, the results of an investigation by David E. Lantz concerning the practicability and desirability of raising deer and other large game animals in the United States.

In most parts of the country the number of game animals is steadily diminishing and game for table use has already become a high-priced luxury. Experiments have shown that some species, especially of the deer family, can be brought to a state of semidomestication with comparative ease and can be bred and raised at very small cost. The chief purpose of the present bulletin is to call attention to the importance of raising elk and deer for venison, to indicate the particular species most readily reared in preserves, and to emphasize the importance of so modifying state game laws as to encourage the use of private effort and capital in making a marketable commodity of venison and placing it within the reach of people of moderate means. Since the distribution in 1908 of our earlier publication on Deer Farming (Farmers' Bulletin 330) several States have changed their game laws in the interest of this industry, and as its importance becomes known others are sure to follow.

Attention is again directed to the fact that in many parts of the country there are tracts of land of little or no value for agricultural purposes which can be more profitably used for raising venison than for any other purpose.

Respectfully,

Henry W. Henshaw,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.

Introduction 7

Importance of domesticating mammals 8

  Preservation of species 9

  Use in agriculture and transportation 10

  Use for fur 10

  Use for food 10

Selection of species for rearing experiments 10

  The pronghorn, or American antelope 11

  Exotic antelopes 13

    The eland 13

    The nylgai 13

    Smaller antelopes 14

  Importance of the deer family 14

  Native deer of North America 16

    Caribou 16

    Moose 18

    Wapiti, or round-horned elk 19

    White-tailed deer 20

    Mule deer 20

    Columbia black-tailed deer 21

  Exotic deer 21

    Altai wapiti 21

    Japanese sika 22

    The Père David deer 23

    Indian sambar 23

    Axis deer 23

    Small deer 24

  Objections to the introduction of foreign animals 24

The wapiti, or Rocky Mountain elk 25

  Habits 25

  Elk venison 26

  Preservation of the elk 26

  Wild elk in the eastern United States 27

  Experience in raising elk 28

  Elk in the Ozark Mountains 33

  Management of elk in inclosures 36

    Range 36

    Food 37

    Fence 37

    Cost of stock 37

    Viciousness of males 38

    The elk as an enemy of wolves and dogs 39

Page.
The whitetail, or Virginia deer 40
  Experiences of breeders 42
    A domesticated herd of deer 44
    Increase of white-tailed deer in domestication 45
    Deer hybrids 45
  Habits and management 46
    Vicious bucks 47
    Capturing live deer for shipment 48
  Wild deer in private preserves 50
    Effect on game supply 51
Game propagation and game laws 52
  Transportation of live deer 52
  Transportation of venison 52
  Killing deer raised in private parks 53
  Sale of venison 54
  State laws recognizing private ownership of deer 55
Resolutions by the American Breeders' Association 58
Summary 59

ILLUSTRATIONS.

Page.
PLATE I. Elk herd in the National Zoological Park, Washington, D. C.. Frontispiece.
II. Elk in the National Zoological Park, Washington, D. C 18
III. Fig. 1. Feeding time on farm of C. H. Roseberry, Stella, Mo. Fig. 2. Mule deer, National Zoological Park, Washington, D. C 20
IV. Elk in new pasture, near Eureka Springs, Ark 34
V. Elk park in the Ozarks, showing elimination of underbrush 34
VI. Tame elk on Indian Rock Game Preserve, owned by C. D. Richardson, West Brookfield, Mass 36
VII. Virginia deer in park belonging to Thomas Blagden, Saranac Inn, Upper Saranac, N. Y 42
VIII. Fawns of the Virginia deer at Kent Deer Park, home of C. H. Roseberry, Stella, Mo 44

RAISING DEER AND OTHER LARGE GAME ANIMALS IN THE UNITED STATES.

INTRODUCTION.

Under present conditions in the United States, game animals of most kinds are rapidly diminishing in numbers. As game becomes scarcer, legal restrictions upon its pursuit and capture are of necessity increased to avoid complete extermination. Even after game is legally killed, the laws of some States make it impossible for the nonresident hunter either to carry the meat home to his family or to sell it. In the zeal for protecting our fast vanishing game animals, laws have been enacted which, unless modified, will hinder or permanently prevent the most important movement for game preservation yet tried in this country; namely, the propagation of game animals, not by the State alone, but by private enterprise as well.

A few States have recently modified their game laws so as to permit, under limitations, the sale of game from private preserves; but in many States restrictive laws still prevent the grower of such game from marketing it outside the State in which it is produced, or within the State except sometimes during a short open season. Complaint is made that our game laws favor sportsmen of means and are unfavorable to the farmer and to those citizens who, while themselves debarred from the pleasures of the chase, would like occasionally to have game on their own tables. If they could purchase venison grown in preserves, it would remove cause for complaint, and the traffic could be so regulated as not to hinder but to aid the protection of wild game.

It is here urged that if the natural resources of the country are the heritage of the people, they should be conserved for the benefit of all. If private enterprise can help in game preservation, it should be allowed to profit from investments. The propagation of game is as legitimate a business as the growing of beef or mutton; and the producer should be permitted, under reasonable regulations, to dispose of his product at any time, either for breeding purposes or for food.

The present bulletin discusses briefly the importance of domesticating wild mammals and the economic objects to be gained by the process. It calls attention to the species, especially those of the deer family, most promising for experiments in meat production, and relates successful experience in different sections of the United States with the wapiti, or Rocky Mountain elk, and with the Virginia deer. It discusses the relation of game laws to the business of growing venison—a business which, it is believed, with proper encouragement may be made highly profitable, especially since it will be the means of utilizing much otherwise unproductive land.

IMPORTANCE OF DOMESTICATING MAMMALS.

The question of practical benefits to be derived from domesticating more species of mammals than we now have is by no means settled. It is claimed by some that the present list of domesticated kinds is ample for all economic requirements of the human race; that, so far as beasts of burden are concerned, we already have enough suited to every necessity; and, furthermore, that mechanical ingenuity is fast bringing us to a time when fewer kinds will be required. As to food animals, we are told that the excellence of our beef, pork, and mutton leaves nothing further to be desired. For clothing, it is said that the wools and hairs produced by mammals already under domestication amply supplement the vegetable fibers.

On the other side, we have the argument advanced by the French zoologist, E. Trouessart, to the effect that mankind should now make every effort to domesticate as many species of mammals as possible. He argues that in the course of time the extensive use of electricity and machinery must inevitably exhaust the coal, petroleum, and natural gas from the earth's crust, and that mankind will again be forced to rely largely upon the labor of animals. He urges immediate action because of the imminent danger of extermination of some of the species.[a]

Between these opposite views a middle ground may be maintained. Admitting that we have enough beasts of burden and as great a variety of animal food as the actual necessities of man demand, we still find excellent reasons for desiring to increase the number of species under domestication. While it is neither necessary nor desirable to domesticate every mammal possible, the field for choice is large. Preliminary to choosing a species its ultimate usefulness must be considered. In reply to the oft-repeated argument that it takes so much time to develop a domestic species that the probable economic advantage will be overbalanced by the enormous expense required, it is enough to recall the fact that many wild animals show remarkable adaptability to the conditions imposed by domesticity. Canada geese, for instance, reared from the eggs of wild parents and kept with barnyard fowls show hardly any trace of wildness.

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[a] Bulletin de la Société d'Acclimatation for 1900, pp. 33–52, 1900.

Young mammals of various kinds when caught wild and reared in captivity become absolutely tame and tractable. If these tame individuals can be bred successfully, there would seem to be few obstacles in the way of domesticating the species.

However, the problems of domestication are not quite so simple as the above statement might imply. It must be remembered that captivity and changes of environment often make wild animals peculiarly susceptible to disease. These and other considerations complicate the problems, whose solution, after all, will depend mainly upon the patience of the experimenter.

In considering the reasons for domesticating wild animals and plants, the æsthetic one should not be overlooked. A large number of the species that have come under human control have been tamed for the pleasure they afford to their owners. This is true of flowering and other ornamental plants, and of some birds—for instance, the canary. Probably this consideration always has weight in the selection of species and individuals for breeding, and it must have a marked influence in deciding the fitness of wild species of mammals for domestication.

Experiments in breeding wild mammals need not necessarily be with a view to complete domestication. The animals may be bred in inclosures giving sufficient range and a habitat as nearly natural as circumstances will permit, and the problems of ultimate domestication may be left for future determination. By this means the practical economic results of full domestication may be largely anticipated before the completion of the process, and the dangers incident to close captivity may be happily avoided.

The chief practical objects to be sought by breeding wild mammals in captivity are: (1) Preservation of species, (2) use in agriculture or transportation, (3) use for hides and fur, and (4) use for food.

PRESERVATION OF SPECIES.

The rapacity of man has often threatened the existence of valuable animals. The danger of extinction of the American buffalo, the African elephant, the eland, the walrus, the sea otter, and other species is not imaginary. Within recent times several species of birds have been lost to the world. Of mammals the quagga and the blaubok (*Hippotragus leucophæus*), the latter a small relative of the roan antelope, have been exterminated in South Africa. Foresight might have preserved them, and foresight, aided by governmental intervention, will be needed to prevent the loss of many of the larger game animals of the world. Their preservation is in itself a sufficient reason for attempting their partial or complete domestication.

USE IN AGRICULTURE AND TRANSPORTATION.

The need of more kinds of beasts of burden is not great. The horse will never be surpassed in general usefulness in this capacity, and the other animals used in agriculture and commerce are excellent in their places. However, there are parts of the world where for special reasons the domestication of species of the native fauna might be of immense advantage to the people. The zebra and the elephant for Africa and the caribou for arctic America are examples.

REARING MAMMALS FOR THEIR FUR.

An important object to be attained by the rearing of wild mammals is the permanence and increase of our supply of furs. The growing scarcity of the better kinds of fur and the consequent high prices make the problem of domesticating fur-bearing animals of immense economic importance, while present conditions promise good returns to those who solve it. The beaver, the otter, the marten, the mink, the silver-gray fox, and the blue fox are among the mammals whose partial domestication and successful breeding would prove profitable.

REARING MAMMALS FOR THEIR FLESH.

From the economic point of view, the strongest argument for breeding mammals in captivity lies in their utility as food. For successful game propagation a less degree of domestication in mammals will suffice than when they are reared for fur or for use in agriculture and transportation. This circumstance greatly favors the game propagator. Besides, there is little probability that breeding game as an industry will ever be overdone; the demand for the product is likely to keep pace with the supply.

SELECTION OF SPECIES FOR REARING EXPERIMENTS.

The larger game quadrupeds are the first to suggest themselves as suitable for propagation for food. The majority of our domestic mammals belong to the order of hoofed animals (Ungulata), and of these the most valuable food species are in the cloven-hoofed division (Artiodactyla). Pigs, goats, sheep, and oxen belong to this suborder; and to the wild members of this group we naturally look for additions to the list of domestic food animals.

The number of animals available for rearing experiments is quite large; but from any complete list of those adapted to a particular country a number of promising species would be rejected as superfluous. As a rule the kinds native to a region should have first consideration, since they need no acclimatizing. The selection of a foreign species for breeding must depend upon a similarity between its natural and its proposed habitat or upon its probable adaptability to the new environment. Adaptation may sometimes be judged from the history of former attempts to acclimatize it or its near relatives. In a country so extensive and varied as the United States the same principles should be considered before transferring a native species from one locality to another.

Some of the large game mammals whose partial domestication in the United States has been favored are briefly considered under the following subheads:

THE PRONGHORN, OR AMERICAN ANTELOPE.

The pronghorn (*Antilocapra americana*) is a game animal not closely related to any other living form. While its general characters ally it, as well as the antelopes of the Old World, to the cattle and sheep family (Bovidæ), it differs from other living ruminants in its deciduous and forked horn sheaths, and is usually considered as the type of a distinct family.

A half century ago the range of the pronghorn in the plains region extended from the valley of the Missouri River westward to the Cascades and from the Saskatchewan in latitude 53° north, southward to the Mexican border. In Mexico the species is represented by a paler local race. The eastern limit of the original range of the antelope is not definitely known. According to Baird it was abundant in Minnesota on the plains of the Red River in 1850,[a] and it still occurred in the southwestern counties of that State in the early eighties. Pike found it common in eastern Kansas in 1806. The statements of the explorers of the plains indicate that it was about as abundant as the buffalo, although not seen in such vast herds.

The present distribution and numbers of the pronghorn are a sad commentary upon earlier game protection in the West. A few fugitive bands are now to be found in the cattle country from longitude 101° westward. The story of their decrease in all of the States is practically repeated in the statements of D. C. Nowlin, state game warden of Wyoming, in his annual report for 1906. He says that antelope have decreased to an alarming extent throughout the State; for instance, in three years the Green River herd had diminished from about 6,000 to less than 2,000 head. Hundreds had perished through lack of food during storms, by depredations of wild animals, and through slaughter by Ute Indians. He repeats the recommendation of previous reports that the legislature should prohibit all killing of antelope for a term of years.

In 1909 the legislature of Wyoming at last heeded the repeated recommendations of the game warden by passing a law protecting antelope until 1915. Two other States—Montana and Nevada—passed laws in 1909 protecting antelope indefinitely. Washington still has an open season, but the animals are practically extinct in that State. Three Canadian Provinces—Alberta, Manitoba, and Saskatchewan—have open seasons; and of these, Manitoba has had none of the animals for more than twenty years.

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[a] Report U. S. Com. Patents (Agriculture) for 1851, p. 121, 1852.

In the United States antelope are now protected in every State in which they occur. The close season in Arizona expires March 1, 1911; in Colorado, September 25, 1912; Kansas, March 13, 1918; New Mexico, March 18, 1914; North Dakota, January 1, 1920; Oklahoma, November 1, 1914; South Dakota, January 1, 1911; Texas, July 1, 1912; Utah, March 11, 1913; and Wyoming, September 25, 1915.

Experience shows that the antelope does not do well in close confinement. In zoological gardens it is short lived and seldom breeds. Judge J. D. Caton made a number of efforts to raise antelope in his park at Ottawa, Ill., but the animals died within a year.[a] Other breeders have had similar experience. The difficulty seems to be that of providing a natural environment. Judge Caton stated that the antelope loses its timidity sooner and more completely than any other wild animal whose domestication he had attempted. "When taken young it soon acquires the attachment of a child for the human species, and when captured adult in a short time becomes so tame that it will take food from the hand, and follow one by the hour walking through the grounds." None of Judge Caton's antelope bred, and he concluded that the climate was too humid, and that his pasture lacked the vegetation essential to their health.

The experience of those who have tried to rear the antelope outside its natural range should not deter those who are favorably situated from undertaking further experiments with it. Visitors to Yellowstone National Park have been greatly surprised at the tameness of the antelope herds. Many western ranchmen have successfully reared the young. The animals were allowed perfect freedom, but could not be driven from the premises where they were fed. Reared in natural surroundings, unconfined, and with sufficient range, they would undoubtedly thrive and increase. In a few years by careful and continued taming of the young, one might secure a herd of absolutely tame antelope. Antelope require only a slight fence to confine them. They run very swiftly, but unless closely pressed will not jump an ordinary fence.

The flesh of the young antelope is said to be much superior to ordinary venison. That of mature animals, particularly the males, has a strong flavor; but this might be greatly improved under domestication. A full-grown pronghorn weighs from 100 to 125 pounds, and will dress from 65 to 80 pounds.

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[a] American Naturalist, X, 197, 1876.

EXOTIC ANTELOPES.

The Old World antelopes belong to the family of Bovidæ, and include many valuable food animals. In Africa alone over a hundred species occur, many of them hardy and most of them excellent game. Fully a score of species would be promising subjects for acclimatizing in America. Africa, like our own country, has arid sections, and some of her antelopes are probably especially adapted to the desert lands of our Southwest, and might be used to restock parts of that region from which our own pronghorn has been exterminated. Some years ago a society was organized for the purpose of introducing the gazelle into southern California, but no practical results followed.

THE ELAND.

The eland (*Taurotragus*), the largest of the antelope family, is threatened with extermination over the greater part of its range in South Africa. Its average weight is from 800 to 1,100 pounds, and old males have been known to attain a weight of 1,400 to 1,500 pounds. This animal has often been recommended for rearing in captivity because of the excellence of its flesh, which is superior to beef. Harris, the African traveler, states that while it resembles beef in grain and color, it is far better flavored and more delicate, possessing a pure game flavor and remarkable for the quantity of fat interlarded between the muscles.

The eland was introduced into Holland by the Prince of Orange in 1783. It was acclimatized in England by the Earl of Derby in 1842, and was bred successfully in his parks. After his death the herd passed into possession of the London Zoological Society in 1851, and continued to increase in numbers for many years. In 1899 the Duke of Bedford had a fine herd of 14 elands in the park at Woburn Abbey.

The scarcity of this game animal in a wild state and the consequent cost of obtaining stock would probably make experiments in breeding it in the United States so expensive as to prohibit the attempt by individual enterprise. However, the experience with the animal in Europe gives assurance that, if properly undertaken, efforts to acclimatize it in the United States would be successful.

THE NILGAI.

The nilgai (*Boselaphus tragocamelus*) of India is, next to the eland, the largest of antelope. The animal is ungainly in appearance, and its flesh is somewhat inferior to that of the eland, but its size, its hardiness, and its lack of wildness commend it as a species suitable for domestication. It stands long droughts extremely well, and its flesh is equal to most venison in quality.

Nilgais were first taken to England in 1767. In 1862 a dozen of the animals were introduced into the park of Signor Comba at Mandria, Italy. In ten years the herd increased to 172 head. A small herd is kept by the Duke of Bedford at Woburn Abbey, England. In the National Zoological Park, the Philadelphia Zoological Gardens, and the New York Zoological Park these animals have done well and bred regularly.

SMALLER ANTELOPES.

Some of the smaller members of the antelope tribe are excellent subjects for experiments in acclimatization and breeding in the United States. Among them are the gazelles of Asia and Africa, the duikers, the springbuck, and the roan antelope of Africa, and the Indian antelope, or black buck. Of the duikers (*Cephalophus*) there are over twenty kinds, ranging in size from that of a medium-sized donkey to that of a hare; and all are said to afford excellent venison, while some of them are known to be easily tamed. The Indian antelope, or black buck, has been bred in many zoological gardens, and a herd is kept in the park at Woburn Abbey. It is easily tamed, but, as is the case with many deer and antelope, the tame males become ill-tempered in the pairing season. In the Philadelphia and New York Zoological parks these animals have thrived and increased rapidly.

IMPORTANCE OF THE DEER FAMILY.

The deer family (Cervidæ) stands next to the cattle and sheep family (Bovidæ) in general utility. The flesh is a valuable food, while the antlers or horns, as well as the skins, are important articles of commerce. Venison was more common than beef on the tables of medieval Europe, and was the flesh most commonly eaten by early settlers and frontiersmen in North America. Its dietetic value is enhanced by the fact that it is especially adapted to invalids who require a nourishing yet easily digested food.

In a recently published table showing the time required to digest various foods, grilled venison is given first rank with boiled tripe and boiled rice, as requiring but one hour for complete digestion. Whipped raw eggs, boiled barley, and boiled trout, as well as asparagus and a few other vegetables, require an hour and a half. Grilled beefsteak and mutton require three hours for digestion, while grilled or roasted veal and pork require five hours, or even more.[a]

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[a] Scientific American, CI., 46, July 17, 1909.

Except in a few species like the caribou, only male deer have antlers. Although these horns are deciduous, they are solid processes produced from the frontal bone, and have the physical as well as the chemical properties of true bone. They are of two general types—those more or less broad and flat and those rounded in shape. Those of the flattened type are usually the more massive, but the rounded antlers of the wapiti are exceptionally heavy.

Deerhorn has several uses. It produces much gelatin by decoction, the product being like that from most animal substances. The raspings and waste pieces of the horns used in manufacturing knife handles are either made into gelatin or boiled down into size used in cloth manufacture. At one time deerhorn was a prominent source of ammonia.

The principal use of deerhorn is in the manufacture of handles for knives, forks, and other instruments. In Sheffield, England, some thirty years ago, about 500 tons of deerhorn were used annually in manufacture. India and Ceylon furnished about four-fifths of this material, while about 100 tons came from European and English deer forests. The 500 tons represented the antlers of fully 350,000 deer of various species.[a] In Europe buckhorn is worked up into many useful articles, as umbrella stands, chandeliers, and ornaments for personal wear.

The use of deerskins is well known. As tanned and dressed by the American Indians they are manufactured into a variety of useful and ornamental articles. The inhabitants of some of the Indian villages of the North derive a good income from their manufactures of deerskins into moccasins, rackets, toboggans, and other things for sale. Deer hide makes an excellent leather, its value depending upon the size as well as upon the species from which it comes. The skins of wapiti, for instance, are porous, and the leather does not wear well, while those of the moose and European elk are so thick and hard that the leather is said to have resisted musket balls. In Sweden in former times a pair of elk-hide breeches went as a legacy through several generations of peasants. Formerly about 200,000 deerskins from North America were sold annually in the London market. Half of these were skins of the wapiti. Many were bought for Germany and there manufactured into leggings, but the heavier skins were tanned and manufactured in England. In recent years the export of deerskins from America has fallen off greatly.

Deer hair has a peculiar cellular structure, and is used in some parts of the world for stuffing saddles, for which purpose it is especially suited.

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[a] Simmonds, P. L., Animal Products, p. 182 (not dated).

NATIVE DEER OF NORTH AMERICA.

North America is comparatively rich in species of deer. All of them are valuable food animals, and nearly all have been of great commercial and economic value during the development of the country. While their commercial importance has been greatly lessened as their numbers diminished, they still play an important part in furnishing food in newly settled parts of the United States and Canada, as well as in feeding the native tribes in the far North. Except in States that have extensive forested areas and have protected deer for a series of years, they are rapidly disappearing before the encroachments of agriculture. The remnant are valuable chiefly because they are a natural resource which may be indefinitely developed if carefully husbanded. It is believed that with partial domestication and careful management in state and private game preserves, deer of most of our species may again become abundant. Considering the difficulties, attempts to domesticate them have been fairly satisfactory.

THE CARIBOU.

Several species and local races of the caribou, or reindeer, inhabit the northern part of North America. According to habitat, they fall naturally into two groups. The more northern, ranging beyond the forests, is best represented by the barren-ground caribou (*Rangifer arcticus*). The second group inhabits the forested area south of the other, and its most important representative is the woodland caribou (*Rangifer caribou*). Although they differ little from the wild Old World reindeer (*Rangifer tarandus*) in habits and general appearance, no attempts to domesticate the American reindeer seem to have been made. The larger woodland caribou is said to be exceedingly wild and timid, and for this reason its suitability for domestication has been questioned. The barren-ground species, although small, appears to be much less wild.

Prof. S. F. Baird was strongly of the opinion that American caribou of both groups are as capable of domestication as the European species, and he suggested that such a step would be of vast benefit to Indians of the North. Its success would at once place these people beyond the vicissitudes which are so rapidly sweeping them off. In the end they might "become a pastoral people, and possibly, in time, as agricultural as the nature of the seasons would admit."[a]

In the same paper from which the above quotation is taken Professor Baird suggested further that the domesticated European reindeer might itself be successfully imported and propagated in North

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[a] Report U. S. Com. Patents (Agriculture) for 1851, p. 108, 1852.

America, and that thus the loss of time in attempts to domesticate a wild species might be avoided. After the purchase of Alaska by the United States, the introduction of firearms among the natives led to such slaughter of game that actual starvation threatened some of the tribes. In 1887 Charles H. Townsend advised that the Government should import the reindeer and teach the natives how to care for and use the animals. In 1891 the late Dr. Sheldon Jackson, general agent in Alaska of the Bureau of Education, aided by donations from private sources, purchased a small herd of reindeer abroad. They arrived in Alaska in 1892. Since 1894 Congress has made annual appropriations for continuing the experiment. Up to and including 1904, the total number of reindeer imported from Siberia and Scandinavia was 1,280, and at that time the herds numbered over 8,000. The net annual increase since importations ceased has been about 25 per cent. In 1907 the herds numbered 15,839 animals and the present number is probably not less than 23,000. The introduction of these animals has already proved to be of immense benefit to the natives, who have been taught how to manage them by herders from Lapland and Finland, brought to America for this service.

Through the efforts of Doctor Grenfell, Lapland reindeer have recently been introduced into Labrador and northern Newfoundland, and the experiment promises great success. W. J. Carroll, of St. Johns, Newfoundland, in commenting on the work of Doctor Grenfell, says:

"It is to be hoped that the introduction of reindeer will be the first step toward the domestication of our own caribou. With a quarter of a million of caribou running wild in the interior, increasing at the rate of 10,000 yearly, it will be seen that when Newfoundland wakes up to the possibilities of its caribou herds we will not only be able to have thousands of deer for commercial purposes, but also will have enough to keep this island a paradise for hunters when hunting big game on the continent becomes a thing of the past. As an instance of how they increase and multiply, Doctor Grenfell thinks his herd will be increased by 200 fawns this spring."[a]

While the domestication of the American caribou has been made less important by the introduction of the reindeer, good reasons for breeding the native animals still remain. They would probably be especially useful for crossing with the Old World species. The cross with the woodland caribou would doubtless produce animals of greater size and strength, and the native caribou could constantly be drawn upon for new blood, just as has often been done in the case of the wild reindeer of northern Europe and Siberia.

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[a] Forest and Stream, LXX, 611, April 18, 1908.

THE MOOSE.

The largest living animal of the deer family is the moose, represented in America by a widely distributed species (*Alces americana*). The Alaskan moose, on account of its great size, has been described as a separate species (*Alces gigas*). The European elk (*Alces machlis*) differs but slightly from the common moose of North America.

The moose is still found in some of the wooded parts of Canada, from Nova Scotia and New Brunswick to Manitoba, its range extending into the United States in northern Maine, Michigan, and Minnesota. In the Rocky Mountain region it ranges from northwestern Wyoming northwestward into Alaska. It is still fairly abundant in parts of Alaska and in British Columbia. Under a careful system of protection moose have slowly increased in numbers in Maine. A promising attempt has been made to reintroduce them into the Adirondacks, where they were exterminated nearly fifty years ago.

Perhaps no other American deer is naturally so well adapted to domestication as the moose. Professor Baird relates that a pair of the animals were kept by a man living near Houlton, Me. These had been trained to draw a sleigh, " which they did with great steadiness and swiftness, subject, however, to the inconvenience that, when they once took it into their heads to cool themselves in a neighboring river or lake, no effort could prevent them."[a] Audubon relates another instance of a moose's being trained to draw a sleigh. We are informed by a number of writers that the European species was in former times fully domesticated in northern Scandinavia and, like the reindeer, was used to carry couriers from place to place. They were swifter than reindeer and have been known to draw a sleigh 234 miles in a day. It is said that this use of elk was finally forbidden under heavy penalties on account of their having been employed to facilitate the escape of prisoners or suspected criminals, and the domestication of the animals was consequently abandoned.

Dr. W. T. Hornaday says of the moose that in captivity "it is docile; not foolishly nervous like most deer, but steady, confiding, and affectionate. Moose are easily handled and trained to drive in harness, and in contact with man manifest more common sense than any other species of deer with which I am acquainted."[b]

In spite of this natural tendency to tameness, the efforts that have been made to keep moose in confinement have nearly all failed. A pair were kept in the Cincinnati Zoological Garden for about five years, but this experience is exceptional. Dr. Hornaday expresses

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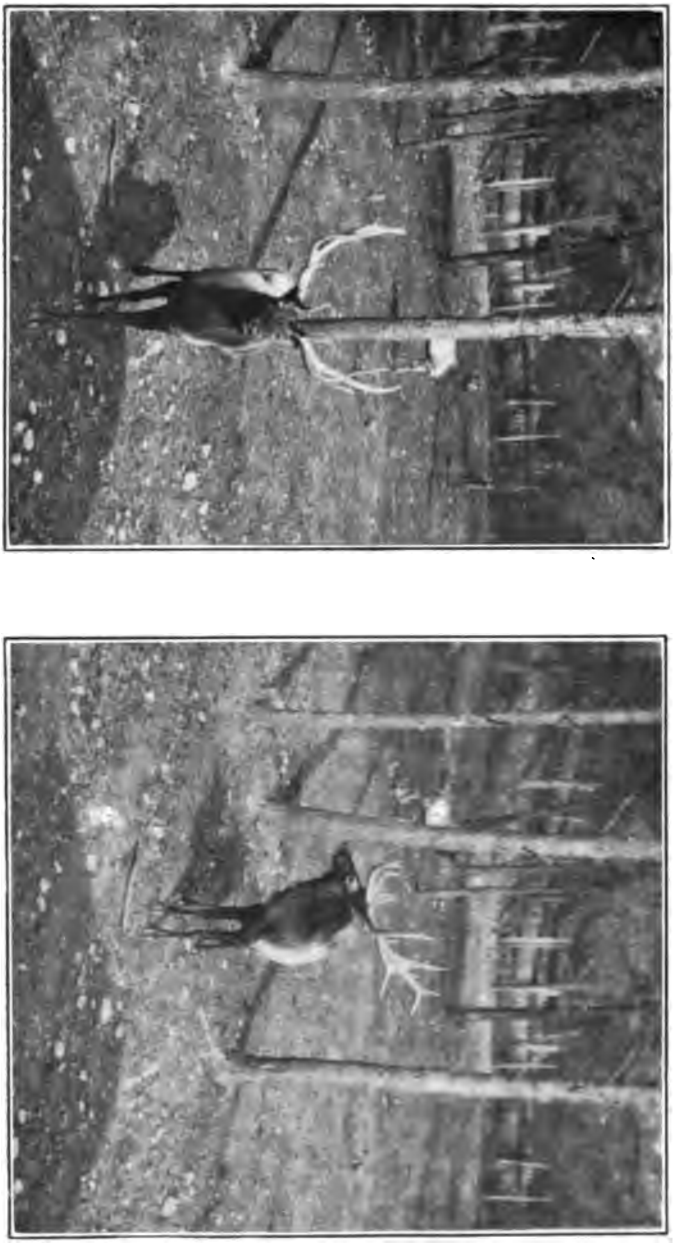
[a] Report U. S. Com. Patents (Agriculture) for 1851, p. 115, 1852.

[b] The American Natural History, p. 141, 1904.



Elk in the National Zoological Park, Washington, D. C.

the belief that the failure is largely due to lack of vigorous daily exercise, which he thinks vitally necessary for the proper digestion and assimilation of their food.[a] Others have suggested that most of the experiments have been made outside of the natural range of moose, and that the climate was too warm for them. On the other hand, individual moose reared away from the parent cow have done well as long as they had the freedom of the forest; and in large preserves, such as the Blue Mountain Park in New Hampshire, the animals are said to thrive and increase. The difficulties in the way of raising them within their natural range are by no means insurmountable, and the practicability of breeding them when confined to forested areas within the Canadian life zone has been proved.

THE WAPITI.

The round-horned elk of North America are best represented by the Rocky Mountain wapiti (*Cervus canadensis*) (Plates I and II); but, besides the typical form, two species and a geographic race occur.

Next to the moose, the wapiti or elk is the largest American deer. Though not a true elk, the name has become too firmly fixed in our vernacular for change. This magnificent game animal was once abundant over a large part of the United States, and extended its range northward in northwest Canada to about latitude 60° in the Peace River region. Southward it ranged to the southern Alleghenies, northern Texas, southern New Mexico, Arizona, and California. The limits of its range eastward were the Adirondacks, western New Jersey, and eastern Pennsylvania. Westward it occurred to the Pacific Ocean.

At present the range of the elk has so far diminished that, outside of the larger herds left in the Yellowstone National Park and the mountainous country surrounding it, the animals occur only in a few scattered localities. The herds in the national park and its vicinity are said to number about 30,000 head. Smaller numbers of the elk still occur in Colorado, Idaho, western Montana, western Oregon, northwestern California, and the Olympic Mountains in Washington. A remnant of the dwarf species of southern California is left in the upper San Joaquin Valley. Outside the United States, a few elk remain in southern Manitoba, Alberta, and on Vancouver Island.

In addition to the wild herds, a considerable number of elk are left in private game preserves and parks, as well as in nearly all public zoological gardens and parks of the United States. These form the nucleus from which, with good management, we may expect a restocking of some of the former ranges of the elk, and from which also a profitable business of raising the animals for market may be developed. At the present time no other member of the deer family seems to offer so promising a field for ventures in breeding for profit. Details of management and records of experience in breeding the elk will be given in another part of this bulletin.

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[a] Hornaday, Wm. T., The American Natural History, p. 141, 1904.

WHITE-TAILED DEER.

The common deer of the United States is the whitetail, or Virginia, deer (*Odocoileus virginianus*). The species is widely distributed and, including the half dozen geographic races that occur within our borders, the range of this deer includes nearly all the United States, except large parts of Utah, Arizona, California, Oregon, and Washington. It is extinct in Delaware and practically so in several States of the Middle West; but it is still fairly common over the greater part of its original range. A number of nearly related species occur south of our borders.

The whitetail is the best known of our native deer and has been bred in semidomestication in many localities. Its suitability for parks is unquestioned, and in large preserves it increases very rapidly. It has not always done well, owing to diseases, but the difficulties in the way of rearing it successfully are not greater than those that attend the management of some of our domestic animals. Its habits and management are discussed later.

MULE DEER.

The mule deer (*Odocoileus hemionus*) (Plate III, fig. 2) is larger than the whitetail, and, though less widely distributed than that species, had originally a vast range on the western side of the continent. Including the six subspecies, or geographic races, it occurred from the Missouri River westward to California and southward into Lower California and Sonora. East of the Continental Divide its range extended north into British Columbia, Alberta, and other provinces to latitude 56° or 57°, and south into Texas. This range has been greatly diminished by the encroachments of settlements and the lack of protecting laws, but the animals are still fairly common in scattered localities except in the open plains country.

Outside of its natural range the mule deer has seldom thrived. Indeed, many of the attempts to acclimatize it east of the Mississippi have failed. In zoological gardens the animals often die of diseases of the digestive organs, but in several places they do fairly well and have bred. They seem to have been thoroughly acclimatized in the large park belonging to the late William C. Whitney,

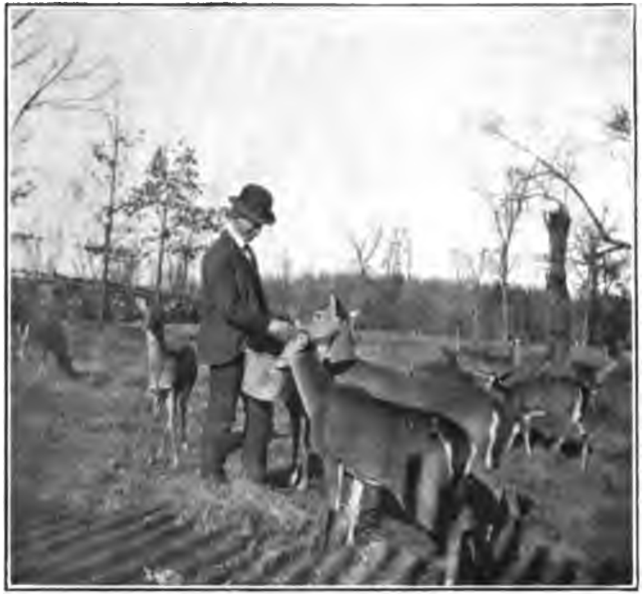

FIG. 1.—FEEDING TIME ON FARM OF C. H. ROSEBERRY, STELLA, MO.

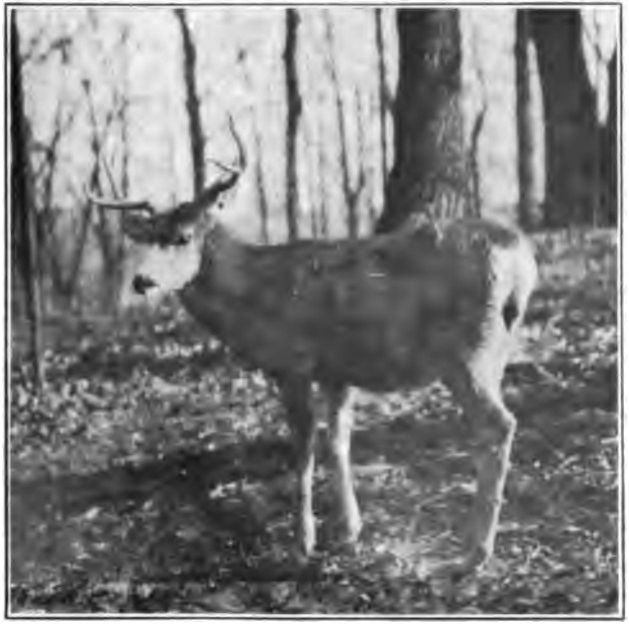

FIG. 2.—MULE DEER, NATIONAL ZOOLOGICAL PARK, WASHINGTON, D. C.

near Lenox, Mass., and they have bred regularly and done well in a small paddock at Crawfordsville, Ind.

The mule deer has been crossed with the Virginia and other deer, and hybrids with the southern Virginia deer have shown a superiority over that race in size and stamina. The hybridizing experiments already made give promise of an unexpected usefulness for the mule deer in captivity. Aside from the difficulty of acclimatizing it in humid regions, no unfavorable circumstances concerning it are known. It is prolific, its venison is excellent, and its superior size adds to its value as a market animal.

COLUMBIA BLACK-TAILED DEER.

The Columbia black-tailed deer (*Odocoileus columbianus*) is smaller than the mule deer or the typical Virginia deer. With its two geographic races it inhabits the Pacific coast west of the Cascades in northern California, Oregon, Washington, and British Columbia to southern Alaska. Although its home is in a humid country, it has resisted nearly all efforts to introduce it into the eastern United States, and the managers of zoological parks and gardens have about abandoned attempts to keep it. If not closely confined, it does well in parks and preserves within its natural range.

EXOTIC DEER.

Several species of exotic deer have been acclimatized in America; and, since the vast extent of our territory affords a great variety of conditions, it is probable that many more species could be successfully introduced and bred in suitable localities. The red deer and the fallow deer of Europe seem to be well adapted to diverse climates, and are now to be found thriving in parks in many parts of the world, including the United States. A few other species whose habits and general usefulness commend them as excellent subjects for domestication are here named.

THE ALTAI WAPITI.

This wapiti (*Cervus asiaticus*)[a] occurs in the Altai and Thian Shan mountains, and is one of the few deer that have been extensively kept in semidomestication. Large herds of these animals were formerly trapped in inclosures in the Altai Mountains and are kept in captivity for the sake of their antlers, which are cut when in the velvet and exported to China for use in medicine. About 6,000 of the animals are said to be in captivity, but owing to their destruction by hunters, wild wapiti of this species are now rare. Although this wapiti is smaller than the American species, the antlers are much larger. They sell at about 15 roubles ($7.50) a pound, and a single pair sometimes brings 120 roubles ($60).[a]

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[a] The proper scientific names of many exotic deer are in doubt. In this and one or two other instances the names here adopted are those used by Lydekker in his recent books on big game.

The Altai wapiti has been kept in parks in various parts of Europe, notably at Woburn Abbey, where the Duke of Bedford in 1896 introduced three stags and several hinds, purchased from Mr. Hagenbeck, of Hamburg. They have done well, but are in no way superior to the American wapiti, with which they interbreed. The Altai wapiti has bred in the Philadelphia Zoological Gardens.

THE JAPANESE SIKA.

Experiments in breeding the Japanese sika (*Pseudaxis nippon*) in Europe and America show that it is one of the most promising of the deer family for park purposes. It inhabits northern China, Manchuria, and Japan, but the Japanese race has been oftenest the subject of experiments in breeding.

One of the earliest to try this species in European parks was Viscount Powerscourt, of Powerscourt, in Wicklow, Ireland. In 1860 he purchased from Jamrach, the London dealer, a stag and three hinds and removed them to his estate, where they throve and multiplied greatly. In 1884, after twenty-four years of breeding and increase, his herd consisted of over 100 individuals, although 2 or 3 yearly had been shot, many given away, and others sold. Several deer parks in Ireland, England, and Scotland were stocked with this species from Powerscourt, and the animals thrived well in every place to which they were taken.

In 1879 Lord Powerscourt wrote:

> Japanese deer require no care of any kind; they are as hardy as fallow or red deer, and the venison is as good. We had a haunch last year with more than 2 inches of fat on it. The haunches are small and of a handy size.[b]

Again, in 1884, he said:

> These pretty little deer are the only [introduced] ones which have multiplied, and have also never required any shelter of any kind, nor any winter feeding, except what the ordinary red deer and fallow deer get, such as hay, etc. * * * The Japanese deer here have undoubtedly interbred with the red deer; there are three or four deer in the park here which are certainly hybrids, the red hind in each case being the dam. The Japanese are a most satisfactory little deer; the venison when dressed is about the size of Welsh mutton and very well flavored. The little stags, with their black coats and thick necks, like miniature sambur, are very picturesque and ornamental, and I think they are a decided addition to our varieties of hardy park deer. Some of them are always to be seen in the Society's gardens, but these give no idea of the beauty of the animals when in a wild state in a park.[c]

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[a] Lydekker, R., Great and Small Game of Europe, Asia, and America, p. 67, 1901.

[b] Proc. Zool. Soc. London for 1879, p. 294, 1879.

[c] Proc. Zool. Soc. London for 1884, pp. 208, 208, 1884.

Although the Japanese sika will take boughs when offered, it is chiefly a grazing animal. It is a rough feeder and thrives on the same food that cattle eat. The fact that it flourishes in the humid climates of Ireland and the Hawaiian Islands shows that it would probably do equally well in almost all parts of the United States. It has been successfully bred in most of the zoological parks of this country, and no obstacle to its successful propagation in open parks is known.

The Peking sika (*Pseudaxis hortulorum*) is larger than the Japanese species, much more vividly colored in summer, and, judging from the experience of the Duke of Bedford with his herd at Woburn, it also is admirably adapted for private parks in humid parts of our country.

THE PÈRE DAVID DEER.

The Père David deer (*Elaphurus davidianus*) is mentioned here because the species is now unknown in a wild state. When discovered by Père David none were known outside of the herds in the Imperial Park of the Emperor of China. The subsequent destruction of the imperial herds in 1894 left the few individuals that had been taken to Europe, and their progeny, the only known living representatives of the species. It is now thought that the herd at Woburn Abbey are the sole survivors. They seem to be thoroughly acclimatized there and to be increasing from year to year.

INDIAN SAMBAR.

The Indian sambar (*Cervus unicolor*) is a large species with several geographic races. Although Lord Powerscourt failed to acclimatize these animals in his park in Ireland, they flourish at Woburn Abbey, where they are kept in the open. At Powerscourt the dense thickets and lack of sunshine were fatal to these deer. The species does well in zoological gardens and public parks, and it has often been recommended for private preserves. Like the wapiti, the male is vicious during the rutting season.

AXIS DEER, OR CHITAL.

The chital or spotted deer (*Cervus axis*) of India and Ceylon is one of the handsomest of ruminants. It is one of the few deer that is spotted with white throughout the year. The species has been successfully bred in European parks and in zoological gardens in many parts of the world. Although native to a warm country, it does well in England and the United States. At Woburn Abbey the herd is always in good condition. Its beauty makes it very desirable for parks. Unlike our native deer it sheds its horns irregularly and breeds at almost any season. It has been crossed with the Virginia deer.

SMALL DEER.

The exotic species thus far mentioned are as large as our common deer, or larger. On our American farms and ranches, especially in the South, there is a distinct demand for a food animal of smaller size than the sheep for family use. A number of species of small Asiatic deer might admirably fill this want. Among them are several of the muntjacs (*Cervulus*) and the Chinese water deer (*Hydrelaphus inermis*).

The Indian muntjac (*Cervulus muntjac*) is probably the best-known species of this genus. It is a beautiful little deer, with small horns, and stands 20 to 22 inches high. The animals live in thickets and tall grass, and are said to be solitary except when pairing. They are timid and seldom seen except when running away from beaters. When cornered they defend themselves with the long canine teeth and not with horns and hoofs like other deer. The period of gestation is six months, and two young are produced at a time. The animals feed like sheep on almost any herbage. They thrive in English parks and would probably flourish in our Southern States. The flesh is said to be excellent.

The Chinese water deer is less solitary in its habits, but in size and some other characteristics it is like the muntjacs. It is the most prolific of all the deer family, the female producing three or four young at a time. It is suited to marshy lands.

If any one of the various small species of deer or even antelope could be raised in the Southern States, it would furnish the farmers a much needed form of meat, which could be provided fresh every day or two as needed. Aside from fowls most of our domestic animals are too large for immediate consumption by the ordinary farmer's family. The successful introduction and breeding of a small mammal, in size intermediate between a hare and a sheep, would be of sufficient economic importance to warrant the expenditure of considerable sums of money in experiments. But this statement is true also of the domestication of any other deer.

OBJECTIONS TO THE INTRODUCTION OF FOREIGN ANIMALS.

In suggesting the acclimatization of foreign game animals, the Biological Survey does not advocate their indiscriminate introduction into the United States nor the immediate release of any of them to resume their wild life. The history of the introduction of beneficial animals into new localities should teach caution in such experiments. Even species fully domesticated have become injurious when neglected and allowed to run wild. Devastations of crops by horses, cattle, pigs, and goats, introduced into new countries for domestic use and afterwards abandoned, have been known in many parts of the world. The destruction of native birds and mammals by dogs and cats that have gone wild furnishes an equally valid argument for caution. Probably less danger attends the acclimatization and release of the class of animals under discussion than any other; and yet it is known that deer and antelope under certain circumstances have increased so enormously as to destroy important crops. Ordinarily should they prove injurious in the United States, the removal of protection would be followed by their speedy extermination as game.

THE WAPITI, OR ROCKY MOUNTAIN ELK.

HABITS.

In this bulletin the life history and habits of the Rocky Mountain elk are discussed only so far as they bear on the care and management of the animals in captivity or in game preserves.

On account of its size, the elk holds a place among American deer much like that occupied by the red deer among European Cervidæ. Although a larger species, its general resemblance to the red deer caused early immigrants to apply that name to it. In New England, where there were no elk, the common Virginia deer was called the red deer. This confusion of names probably led to the adoption of the name elk for the wapiti because of its size. In view of its resemblance to the red deer so common in parks in the Old World, it seems strange that attempts to domesticate the wapiti in America were so long delayed.

The elk is both a browsing and a grazing animal. While it eats grass freely and can subsist upon it alone, it thrives best where there are also trees and underbrush. In its former range, when the surroundings permitted, it retreated into mountains and woodlands in summer, where it fed upon buds, twigs, leaves, and woodland grasses, while in winter it grazed chiefly in open prairies or glades, unless driven to timber by deep snows. The Wyoming herds summer chiefly in the high mountain pastures of the Yellowstone Park, and when these become covered with deep snow the animals retreat to the valleys southward and eastward of the park. They formerly ranged far out on the plains in winter, but intense summer grazing by cattle and sheep now leaves the winter pasturage too scant for them.

The American elk is extremely polygamous. The horns of adult bulls usually drop off in March or April, and new ones attain their full size within ninety days. The velvet adheres until about August, when it is gradually shed. The animals hasten the shedding by thrashing their horns against small trees and bushes. This is often referred to by hunters as "shaking," from the fact that the motion of the trees may be seen at great distances. The bulls usually lead solitary lives while the horns are growing, but early in September, when the antlers are fully matured, the rutting season begins, and the bulls seek the herds of cows. Fights for supremacy then take place, and the victor takes charge of as many cows as he can round up and control.

In spring the cows remain in small herds until nearly time for the calves to be born. Then each seeks a secluded place, where she remains until the calf is strong enough to follow. In late summer the cows and calves begin to collect into small herds and are soon joined by the bulls. The period of gestation in the elk is from 249 to 262 days (average about 8½ months). The calves are born in May or June and, like the young of the common deer, are spotted, but the spots are not so numerous nor so clearly defined, and they disappear in September with the first shedding of the hair. The female elk does not have young until three or four years old, and usually produces but one calf at a time. The calf follows the cow for a full year and sometimes even longer.

ELK VENISON.

The flesh of the elk is superior in flavor to most venison. The bulls are in best condition about the time the velvet is shed. By the time the rut is over, in October, the flesh is in the poorest condition. As the hunting season is usually in October and November and only males are killed, sportsmen often obtain the venison in poor condition, and, as a result, many persons have found fault with the flavor of elk meat. It is not best when freshly killed, but after hanging four or five days it becomes palatable and nutritious. Of course fat elk are better than lean, and it is said that the venison from castrated bulls is superior to that from others.

PRESERVATION OF THE ELK.

The preservation of the Rocky Mountain elk is of even greater importance than that of the American buffalo. While the destruction has not gone so far as in the case of the buffalo, absence of the elk from nineteen-twentieths of its former range is to be even more regretted. The buffalo was especially adapted to the prairies and the plains, and economically its place is better filled by the domestic cattle that now graze there. On the other hand, the elk is equally well, if not better, suited to rough, wooded areas not well adapted to cattle. Its preservation, therefore, may economically utilize such land, and the animals may become a valuable resource to the State as well as to the private owner.

The value of game to the State is seldom so fully appreciated that it is properly conserved and made to yield permanent returns. Maine probably secures the best value from its big game. Deer and moose in that State now pay a large part of the cost of game protection: the addition of a small resident license fee for hunting would make the actual revenue exceed considerably the cost of fish and game preservation. In addition, licensed guides earn about $360,000 a year, while hotel keepers, railroads, express companies, and others derive greatly increased incomes from the sportsmen and tourists who are attracted to the State by its excellent hunting and fishing. Any State that has big game may profit by its preservation, and owners of private big game preserves should find them equally remunerative.

Its polygamous habit is a favorable factor in preserving the elk. The extermination of the buffalo was hastened by the fact that hunters, both white and native, preferred to kill the cows. Their flesh was superior to that of the bulls, while the robes they produced were of finer quality. In the course of time polyandry became so fixed among buffaloes that reproduction fell much below the normal rate. In the case of the elk, polygamy is the rule; and the destruction for trophies of males only, as well as the laws of States which forbid the killing of does, serves to perpetuate the species. The breeding of the animals is thus kept at a maximum rate.

The fact that elk congregate in large herds in winter has been unfavorable to their preservation. Pasture in their winter ranges is often insufficient for the demand, and the weaker animals perish. In recent years, because of the encroachments of cattle and other stock upon the range, elk winter higher up in the mountains, where the snowfall is great. Poachers wearing snowshoes often approach and destroy an entire herd. Under adequate protection and with a proper supply of winter forage the gregarious habits of the elk would give increased security to the herds, but conditions hitherto have not brought about such results. On the contrary, wherever elk have been abundant much unlawful slaughter of the animals has taken place. Not only have nonresident hunters engaged in the business of killing them for heads, hides, and tusks, but residents of the game country have sometimes engaged in the same nefarious practice.

WILD ELK IN THE EASTERN UNITED STATES.

Probably the last wild elk of the original stock east of the Mississippi was killed in November, 1867, in Elk County, Pa., though possibly a few remained a little longer in the mountains of West Virginia. A few wealthy men have stocked private preserves with elk from the Rocky Mountains, and the experiment of acclimatizing them in the East has proved uniformly successful. A number of preserves in New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, and North Carolina have been noted for fine herds of these animals, the best known, perhaps, being those of Austin Corbin and William C. Whitney, both deceased. The Corbin preserve is on Croyden Mountain, near Newport, N. H., and the Whitney preserve was on October Mountain, near Lenox, Mass. At Mount Pocono, Pennsylvania, Carl Tielenius has a considerable herd of elk, kept on lands over which the wild elk ranged in the early part of the last century.

The New York Forest, Fish, and Game Commission have made in the Adirondacks the first systematic efforts in the East to restore elk to their former ranges. In June, 1901, the late William C. Whitney presented 22 head of elk—5 bulls and 17 cows—from his Massachusetts herd. This was followed in 1902 and 1903 by two gifts of larger herds from the same source and in 1906 by a gift of a herd of 26 from Mr. Corbin's Blue Mountain Forest Park, in New Hampshire. The elk were liberated in small bands at various places, mostly on state lands, and their increase has been satisfactory. It was estimated that on December 31, 1906, the total number at large in the Adirondacks was about 350 head.[a] The elk, under proper protection, may be expected to become abundant again in the North Woods. The example of New York might well be followed by all States that have wild lands suitable for the elk. Pennsylvania has ideal places for the animals in her game preserves recently established, and all the States traversed by the Allegheny Mountain ranges have abundant wild lands for the introduction of the species. The cost of stocking with the animals would be slight compared with their ultimate value to the State. In New Hampshire there is reason to suppose that the beginning of a wild herd exists in animals that have escaped from the Corbin preserve. Forty-eight elk in one herd are reported to have been recently seen running at large in the forests.[b]

EXPERIENCE IN RAISING ELK.

Although the American wapiti is less prolific than the common deer and some other species that have been bred in parks, it increases quite as fast as the red deer and is more hardy and easily managed. It has been successfully acclimatized in many parts of the world, and in England and on the Continent it has been crossed with both the Altai wapiti and the red deer. The hybrids in both cases were superior to the native stock in size and stamina.

The elk has been successfully bred in confinement in many parts of the United States, and in some instances has been domesticated. Audubon and Bachman say of it:

> This species can be easily domesticated, as we have observed it in menageries and in parks both of Europe and America. The males, like those of the Vir-

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[a] Field and Stream, XII, 598, November, 1907.

[b] Recreation, XXVII, 129, March, 1908.

ginia deer, as they advance in age, by their pugnacious habits are apt to become troublesome and dangerous. The elk lives to a great age, one having been kept in the possession of the elder Peale, of Philadelphia, for thirteen years; we observed one in the park of a nobleman in Austria that had been received from America twenty-five years before.[a]

Professor Baird was of the opinion that the elk could easily be domesticated, and that, next to the caribou and the moose, it is the "one to which we are most entitled to look for an increase of our stock of domestic animals. The great size of the horns of the male, and his fierceness and uncontrollability during the rutting season, are certainly obstacles in the way of reducing the elk to the rank of a servant to man; nevertheless they are not unsurmountable, after all." He suggested that, as in the case of the buck of the common deer, castration would effectually subdue the animal. He suggested further that if the social instinct is necessary to the complete domestication of an animal, no deer possesses it in a higher degree than the elk, which is often found in immense herds.[b]

One of the earliest successful attempts to domesticate the round-horned elk was made by Col. John Mercer, of Cedar Park, West River, Md. Colonel Mercer obtained his stock from St. Louis about seventy-five or eighty years ago. The animals were transported to Wheeling by water and thence to West River by way of Cumberland on foot. A few other breeders obtained stock from Colonel Mercer, among them Col. Joseph Tuley, of Millwood, Clarke County, Va.

Lorenzo Stratton, of Little Valley, Cattaraugus County, N. Y., began experiments with this species about sixty years ago. In a letter addressed to D. J. Browne, and dated January 12, 1859, he says:

> The American elk, with all its claims to attention, is fast disappearing from the earth, with scarcely an effort for its preservation or domestication. By domestication I do not mean simply taming, but a course of intelligent breeding and protection. A series of experiments with this animal * * * has furnished me with sufficient evidence to say confidently that this business may be made of great importance to the country. * * * I have now a herd so gentle that a visitor at my farm would hardly imagine that their ancestors only three generations back were wild animals. * * *
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> The facility for extending this business may easily be conceived. New York alone might support 100,000 elks on land where our domestic cattle could not subsist; furnishing an amount of venison almost incredible; while the adjoining State of Pennsylvania, to say nothing of others, might sustain a still larger number without encroaching upon an acre of land now used for stock rearing, or any other purpose connected with agriculture.[c]

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[a] The Quadrupeds of North America, II, 92, 1851.

[b] Report U. S. Com. Patents (Agriculture) for 1851, p. 118, 1852.

[c] Report U. S. Com. of Patents (Agriculture) for 1858, p. 237, 1859.

At a meeting of the American Institute in New York January 6, 1862, Mr. Stratton gave a detailed account of his experience in domesticating the elk, in which he said, in part:

> About eight years ago I had an opportunity to purchase two elks. I did so as a matter of curiosity and because I wished to see a few specimens of this forester preserved, as my place is situated in the region where they used to roam in countless numbers. They did well and bred. I fenced off a few acres for them, and found after a while that I could certainly raise venison cheaper than my neighbors could raise beef. I devoted a large plat of stony, bushy land, unfit for any other purpose, to them. Since then I have succeeded in breeding 37 elk. I have had no accident of any kind amongst them, and they have fatted and bred regularly and have become quite domesticated. The does have been gentle and act like domestic cattle. The bucks have been also gentle until they were about 4 years old, when they have been difficult to manage in September and October, like a bull or stud-horse. In such cases I generally made venison of them. Excepting these instances, however, the animals are quite docile. The first fawn that I raised was very shy. He was in a lot of about 15 acres, and when I went to him he would flee from me, so that I could hardly get a sight at him. The next fawns raised were not so frightened when they saw me, and now when I go into the field the young fawns are like so many calves. My lot is fenced with common rails, 6 or 7 feet high, and there is no difficulty in keeping the animals within bounds. Frequently, when the fence may get down, they go out into a neighboring piece of woods, but as soon as anything startles them they run for their own field again, and feel safe only when they arrive there. They are not inclined to stray off. This lot in which they are confined they consider as their home, and chase off any dogs that may come upon it. In four generations, by kind treatment, I have, as I contend, not merely succeeded in taming them, but in domesticating them. They are as gentle as sheep that run wild. * * *
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> * * * The great profit in raising them, however, is for their meat. They live and fatten on useless land. Where the feeding ground is brush they will destroy it; but the grass will come up more profusely on this account in the summer; and it has the result of giving them better feed in the summer though not so good in the winter. I paid $400 for the first pair I bought; I have bought 2 does since then, from which, with the first pair, I have raised my whole stock; I have been at various unnecessary expenses, from the fact that I did not know how to manage them; I can now raise elk cheaper than I can sheep; I have a 3-year-old buck, weighing 480 pounds, which has cost me less than any 3-year-old sheep I have got. I have been anxious to introduce them as common stock and have sold them for $100 a pair. A great many are afraid to buy them, for fear they will get away and go wild again. They see me go into the field and all the flock come about me, and each one tries to get his nose into my pocket; but they say, "I don't believe I could do that." They think there is some Rarey secret about it. When I go into the lot, I generally carry a little handful of salt, or grain, or something which they like, which makes them come about me. * * *
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> I think there is no better meat than that of the elk; it is richer and more juicy than the meat of the deer; I killed a 2-year-old doe this year which had had no fawn; she was very fat; I took 29 pounds of tallow from her, and she weighed 282 pounds dressed, the skin weighing 28 pounds.

At the same meeting Mr. Trimble stated that several years previously, while traveling over the prairie in Illinois, he had seen at a house where he stopped a full-grown elk perfectly domesticated. There were no fences about and it never attempted to run away.[a]

The final outcome of the Stratton experiment at Little Valley was recorded in a communication to Forest and Stream by Mr. E. L. Stratton, of Grand View,, Tenn., a brother of Lorenzo Stratton. He stated that so far as the experiment was carried it was a complete success. "Had there been a moderate amount of capital invested, with a larger territory of cheap mountain land added, and with close attention to the business, it would have been a profitable investment and doubtless would have shown handsome dividends. But when we decided to move South, the elk business had to be abandoned. Most of the stock on hand was bought by some foreigners and shipped by rail to New York, thence some to Italy and the rest to Germany, and three or four were slaughtered at home."[b]

In 1887 T. D. Kellogg, of Whitestone, Long Island, contributed to the New York Herald an interesting account of his observations on domesticating the wapiti, made when a pioneer in northwestern Iowa in the fifties. Mr. Kellogg said that at that time elk roamed over all the plains of that part of Iowa, but already in diminishing numbers. In the spring when a settler had killed a doe elk he would occasionally take home a suckling fawn in his arms and bring it up by hand. Two settlers whom he knew well had each an elk thus domesticated, and several similar instances came to his knowledge. These settlers had no inclosure except a small garden patch, from which stock was excluded by a rude fence.

The tame elk, let loose upon the open prairie, were at full liberty, and although born in a wild state they never joined a passing herd nor roamed far from home. They gave no trouble by getting into the garden or injuring the fence. They were less timid than sheep, although not so familiar as dogs. "Probably no animal in existence," says Mr. Kellogg, "is naturally fitted to take so kindly to domestication as this noble creature, so rapidly disappearing from the face of the earth."[c]

Judge John D. Caton, of Illinois, who contributed so much to our knowledge of the deer family and of their susceptibility to domestication, seems to have been unfortunate in having inclosures poorly adapted to deer. He believed that his pastures contained some kind of vegetable food that was harmful to most of the species, but his elk were always healthy. Writing in 1880, Judge Caton said:

> My elk continue to do well and are so prolific that I have had repeatedly to reduce their numbers and would be glad now to dispose of at least 30. I

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[a] Trans. Am. Institute for 1861–62, pp. 220–223, 1862.

[b] Forest and Stream, XLVIII, 445, June 5, 1897.

[c] The American Field, XXVIII, 126, August 6, 1887.

have on an average about one old buck a year killed in battle and sometimes another by some casualty, but all appear healthy. Mine grow very large and of all the Cervidæ they seem best adapted to domestication.[a]

With few exceptions former attempts to rear elk were made by men who were wealthy and actuated only by a desire to possess or to preserve the animals. Care of them was left to servants. The bucks remained uncastrated until they became old and unmanageable, when the serious problem of caring for them soon outweighed the novelty of their possession, and the experiments were abandoned. This will account for the failure of many of the herds that were founded a half century or more ago.

But these breeders of the elk have not been without successors, and at present there are small herds of elk under private ownership in many places in the United States. The Biological Survey has recently opened communication with owners of herds of elk and deer, for the purpose of learning their experience in rearing the animals and obtaining their opinions as to the feasibility of making the business profitable. Extracts from recent correspondence referring to the wapiti, or elk, follow:

Joshua Hill, of Pontiac, Mich., wrote, October 12, 1907, that he has elk and bison in his preserve of 300 acres. He finds the sale of elk meat slow, but thinks that, if properly pushed, the business of growing it would pay well. In his opinion the elk would be more profitable than deer, since the animals are larger and the venison better. He has heard of elk meat bringing 50 cents to $1 per pound.

Isaac A. Bonine, of Niles, Mich., wrote, under date of October 14, 1907, stating that he had been breeding both the elk and deer for about thirty-five years. He said: "We find that deer are not so hardy as elk and require more care. Elk require less care than the domestic animals, while deer are even more delicate. Deer should have a greater variety of food than elk. Elk winter well on hay and corn fodder with a little grain, and they live and thrive during summer months on blue grass. Deer will live on the foods mentioned here for elk, but they should have vegetables also. They require an open shed or shelter of some sort during winter; an elk requires none. The growing of both elk and deer for park purposes may be made profitable."

J. W. Gilbert, of Friend, Nebr., states (March 17, 1908) that he has been growing deer and elk for seventeen years. The deer have not always done well, but he now has a healthy herd of about 30 head. The elk have increased and done well all the time. He has never had a barren cow elk. Mr. Gilbert's range of 75 acres is on the open prairie, and contains buffalo, deer, and elk.

F. J. Wilson, of Lewisburg, Ohio, began raising elk and deer a few years ago, with three head of each at first. He has not succeeded so well with deer as with the elk. Deer require a higher fence and more care. The elk do well on hay, corn fodder, and other rough feed; if they escape from an inclosure they can be driven back like cattle. Mr. Wilson paid $165 for 2 adult elk and a fawn. He has sold $300 worth of stock, and, in 1908, had a herd of 12 head, worth $1,000.

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[a] American Naturalist, XIV, 396, April, 1880.

The experience of Carl Tielenius with his herd at Mount Pocono, Pa., is less satisfactory. He began about the year 1890 with 26 head of 2-year-old elk, 22 of which were cows. The first year they produced 23 calves, and in the following four years 22, 18, 16, and 12, respectively. In later years with about 80 cows the number of calves has ranged from 5 to 10 per year. The herd is healthy, but reproduction is deficient in spite of the infusion of new blood by the introduction of bulls from the Whitney herd. It is possible that, as Judge Caton suspected to be the trouble in his herd, the bulls at Mount Pocono exhaust themselves by much fighting before the rut begins.

ELK IN THE OZARK MOUNTAINS.

Col. W. C. Wetmore, of St. Louis, writes under date of April 20, 1908, that the St. Louis Park and Agricultural Company, of which he is a member, owns several thousand acres of land in Taney County, Mo. The land is in the Ozark Mountains and the ground rough and hilly, though well watered. A little of the upland and some of the valleys are tillable, and corn and oats are grown in the former and corn and alfalfa in the latter—enough to feed the game when snow prevents their finding their ordinary food. The preserve is surrounded with an 8-foot wire fence, and in it are now about 400 elk and 1,000 deer.

Colonel Wetmore writes further:

> They are hearty and healthy and do well in every way and at all times are fat and marketable. I am thoroughly convinced that the raising of both elk and deer can be made very profitable where the ground, water, and other conditions are favorable. Deer increase very rapidly, as a doe usually drops twins after she is three years old. Elk do not increase so rapidly, cow elk dropping a calf every other year, but they are hardy, and with an experience of over twenty years I have not known one to die of natural causes. * * * I am a lover of all wild game, particularly deer and elk, and I hope you will be successful in interesting people in propagating them. Give them plenty of room to run in and they will do well.

George W. Russ, of Eureka Springs, Ark., has a herd of 93 elk (1909). They have ample range in the Ozarks on rough land covered with hardwood forest and abundant underbrush. He reports that the animals improve the forest by clearing out part of the thicket. Fully 90 per cent of the females produce healthy young, and Mr. Russ thinks he could make the business of growing elk for market profitable if the law would permit him to kill and export the meat.

He has an offer of 40 cents a pound for the dressed carcasses in St. Louis. If, as he claims, he can produce elk meat cheaper than beef, pork, or mutton, this should be a remunerative price. He thinks that large areas in the Alleghenies and Ozarks not now utilized could be economically adapted to produce venison for sale, and he regards the American elk as especially suited for forest grazing.

Mr. Russ, in a letter dated Eureka Springs, Ark., March 7, 1908, sent the Department of Agriculture, through H. N. Vinall, Bureau of Plant Industry, the following answers to the several questions propounded:

Question 1. How many acres per elk of forest land is needed for best results?

Answer. Much depends upon the character of the forest land. In this section of the Ozark Mountains an average of 5 acres to the head. In other sections a larger area will be necessary. The larger the area the better the results. One hundred elk will fare better in a 500-acre inclosure than one elk confined on 5 acres.

Question 2. Would it be possible for individuals to raise elk under grazing permits in large tracts like the national forests without fencing, by some method of feeding in a certain place or by herding?

Answer. We think it possible to raise elk by individuals having permits in the national forests, by a system of feeding in certain places, thereby locating these animals on the range best fitted for them, and by loose herding by well-trained men familiar with their habits. But there are so many contingencies to be reckoned with on an open range that in our opinion it would be far preferable to fence.

Question 3. What is the cost per mile in forest land of an elk fence?

Answer. Again, much depends on distance from railroad, cost of labor, etc.; but ordinarily where posts and stays cost nothing but the making of them a good elk fence can be built for about $200 per mile.

Question 4. Will the elk do any considerable damage to a forest in restricting the growth of young trees of valuable species?

Answer. Elk will feed on buds and leaves 8 feet above the ground, and any growth up to or under this is liable to be eliminated, depending upon the amount of such food. Unless the range is very much restricted they will not eat the bark from trees, neither will they resort to any species of evergreen. (Pl. IV.)

Question 5. What has been the per cent of increase in your herd under domestication?

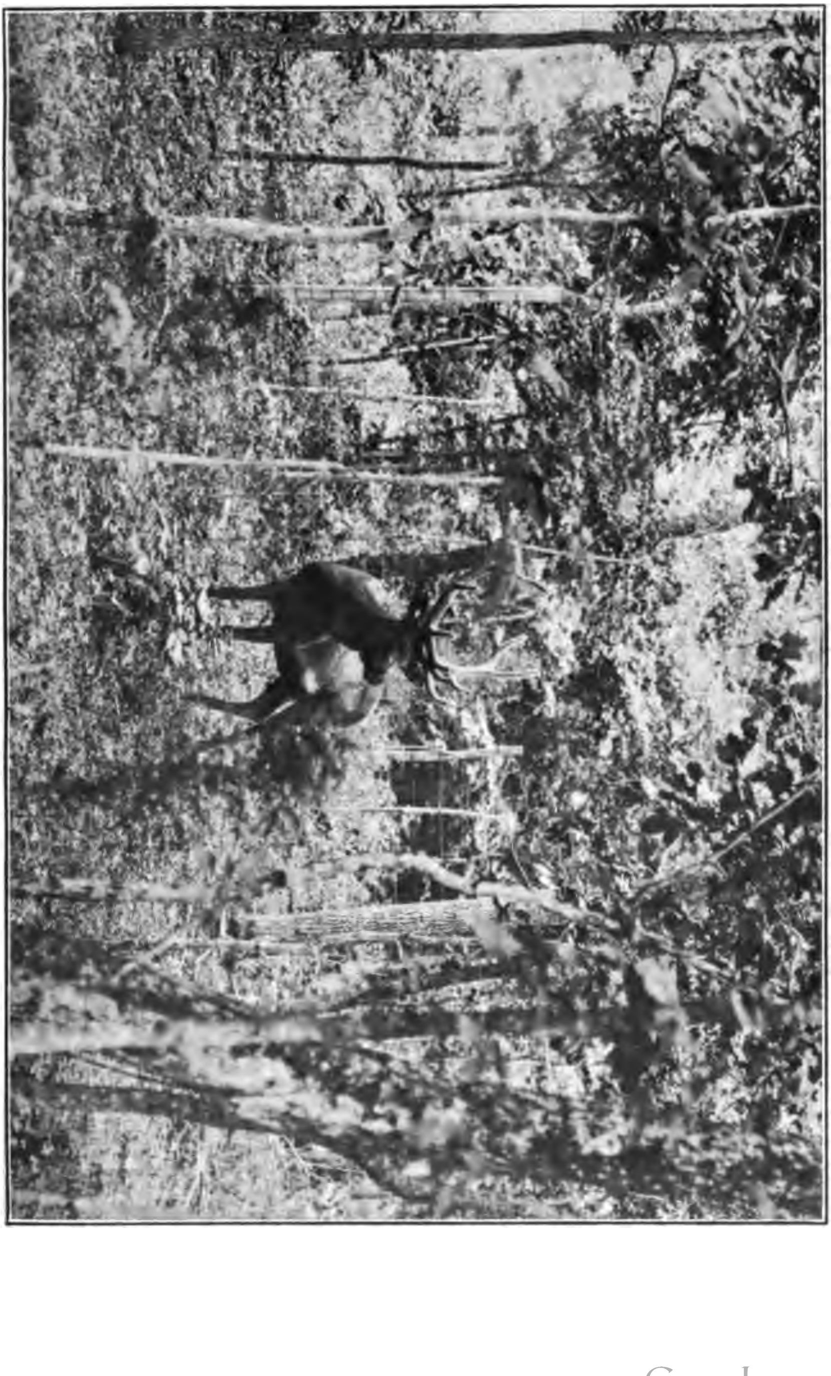
Answer. The increase in elk under domestication is equal to that of cattle.

Question 6. What is the average weight of an adult male? Of a female?

Answer. Male, 700 to 1,000 pounds; female, 600 to 800 pounds.

Question 7. Will they not give a greater per cent of dressed meat than cattle?

Answer. Yes; but owing to the game laws our experience has been limited to a few animals. The per cent of dressed meat is much more.



ELK IN NEW PASTURE, NEAR EUREKA SPRINGS, ARK.

ELK PARK IN THE OZARKS, SHOWING ELIMINATION OF UNDERBRUSH.

Question 8. Is there at this time, or would there be in case the laws were revised, any general demand for elk meat? At what price?

Answer. In answer to this question, we can be guided only by the very limited demand, owing to the law prohibiting the sale of elk meat. We do, however, receive orders from parties not familiar with the law, and letters from many asking us if we are permitted to sell. From the fact that as high as $1.50 per pound has been paid for this meat in New York City and Canada, and that the best hotels and restaurants pronounce it the finest of all the meats of mammals, we are of the opinion that if the laws were such that domesticated elk meat could be furnished it would be many years before the supply would make the price reasonable compared with other meats.

Question 9. What price per pound would you consider necessary to make the production of elk meat profitable?

Answer. Elk meat can be produced in many sections of this country for less cost per pound than beef, mutton, or pork.

Question 10. What laws, state or national, at present interfere with the production and sale of elk meat? What are your recommendations for revising these laws?

Answer. The remedy to the state and national laws is very simple, and at the same time just and equitable. By simply adding or inserting the word "wild" before the name of the animal protected. To guard against abuses, a certificate from the owner of domesticated animals should follow them, and proper penalties should be imposed for any violation of the laws.

Question 11. Would the elk be adapted for browsing in the Appalachian forests from Pennsylvania south to Georgia?

Answer. Yes; I am quite familiar with the Appalachian range, and consider it ideal.

Question 12. Are they as useful as goats in clearing out underbrush? Is it best to use both goats and elk?

Answer. They are more useful, as they will browse as low as goats and twice as high. I would earnestly recommend the use of both goats and elk for clearing up brushy land and fitting it for tame grasses. Elk and goats get along well in the same inclosure.

Question 13. What area will they clear up per year in your section? Keep cleared?

Answer. So much depends on the amount of underbrush as to the average amount elk and goats will keep cleared. The conditions in a mountainous country are much more diversified than in a level one, the growth of underbrush and timber often changing radically in a fourth of a mile. The average conditions in this range of mountains can only be estimated approximately. Our experience has taught us that to get the best results, after stocking with elk and goats, it is best to wait one year before seeding, then continue with elk and goats two years more; when, if properly seeded and pastured, an open woodland pasture of tame grasses will be obtained (Plate V). To accomplish this, our estimate would be an average of one elk and two goats to 5 acres. When the underbrush and weeds have been eliminated by elk and goats, they will be very slow in coming in again. The life has been destroyed by the continued browsing on bud and leaf, and not only is the stem dead but the root also. The perennial weeds have been treated the same way. Those coming from seed must come from outside the fence, and will find the tame grasses in possession. Elk and goats fed on the falling leaves in the fall, thus lessening the covering of grasses. Tame grasses will not thrive under a thick coating of dead leaves.

Question 14. Is the forest open enough after their work to permit the growth of grass?

Answer. Elk and goats do not open up dense forests, except undergrowth. It is necessary to have considerable light and sun for the growing of tame grasses.

Question 15. After the forest land has been cleared and seeded to tame grass, could sheep be grazed in the same lot as the elk?

Answer. In reply to this question, we answer from long experience that cattle, sheep, and goats can be grazed in the same lots with elk, providing, however, that the lots or inclosures are not small—the larger the area the better; and we know of no more appropriate place to call attention to the great benefit of a few elk in the same pasture with sheep or goats. An elk is the natural enemy of dogs and wolves. We suffered great losses to our flocks until we learned this fact; since then we have had no loss from that cause. A few elk in a thousand-acre pasture will absolutely protect the flocks therein. Our own dogs are so well aware of the danger in our elk park that they can not be induced to enter it.

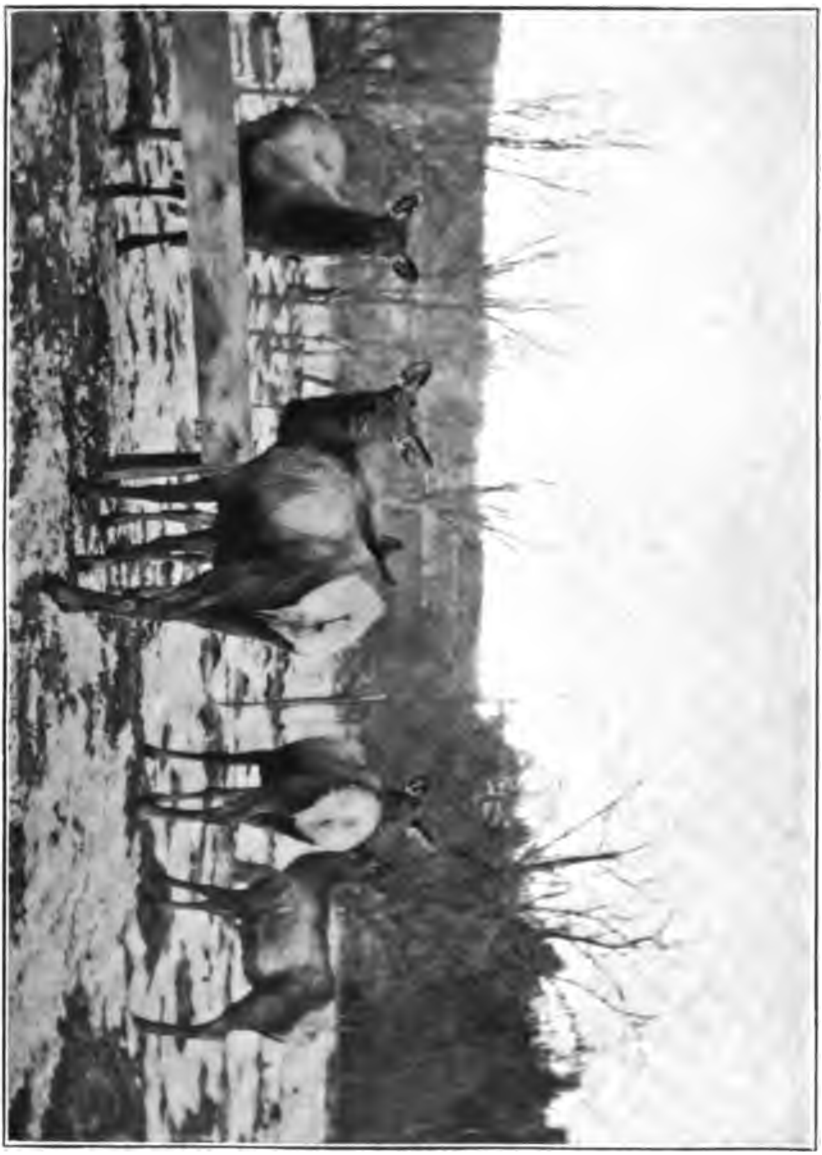
In your note you invite us to suggest any other points not covered by your questions. We think of nothing but feed and shelter. Nature has provided the elk with a winter coat of hair, which is in itself ample protection from any weather conditions, and which makes artificial protection unnecessary. All that is needed is feed, and on account of their browsing on that which is already in our hills and low mountains but little provision is needed. Like cattle, they are fond of grain and can be fattened on it, but may be kept in good condition during the winter on very little roughness. To be more explicit, one-half the ration per pound required for cattle will do for elk. We have opinions about caring for and domesticating the wild elk, saving to the nation what yet remains, and using them as a nucleus for general domestication and distribution. These views we will gladly furnish if desired.

MANAGEMENT OF ELK IN INCLOSURES.

The experience of Mr. Stratton at Little Valley, N. Y., recounted in the preceding pages, gives an excellent foundation for practice in developing a true domesticity in the wapiti; but for economic reasons it may not always be possible for the raiser of the elk to adopt the same methods. He may wish to grow the animals for venison only and on large preserves where the calves can not be tamed when young. But when the elk is grown for stocking parks and private preserves, the tamer the herd the easier will it be to handle and ship the stock.

RANGE.

The natural food supply is an important consideration in choosing a range for the elk. While elk have done well in blue-grass pasture and on the prairie grasses alone, they do far better on preserves



TAME ELK ON INDIAN ROCK GAME PRESERVE, OWNED BY C. D. RICHARDSON, WEST BROOKFIELD, MASS.

which have a variety of food—grasses, bushes, and trees. Rough lands well watered by streams and having a considerable proportion of forested area are best adapted to their wants. On an average such lands will support about the same number of elk as of cattle on the same area without impairing the range. There should be thickets enough to furnish winter browse for the animals. A supply of winter forage of other kinds will prevent the too rapid destruction of shrubbery in thickets.

FOOD.

Except in times of snow, elk will keep in excellent condition on ordinary grass pasture, but a system of management which regularly furnishes other food to the animals will be found better. For winter, hay and corn fodder furnish excellent forage; but alfalfa hay has proved to be the most satisfactory dry food that can be given to either elk or deer. A little oats or corn, whole or chopped, may be fed each day. Elk are fond of corn, and feeding corn and salt affords the best opportunities for winning confidence of the animals and taming them. Salt should be furnished liberally to all deer kept in inclosures. Running water, although not essential, is of great importance in maintaining elk in good condition. (Plate VI shows a small herd of elk at feeding place in winter.)

FENCE.

Elk are not nervous like the common deer and seldom jump an ordinary fence. A fence 5 feet in height is usually sufficient to confine elk, and Henry Binning, of Cora, Wyo., thinks a 4-foot woven-wire fence is ample. When they escape from an inclosure in which they have been fed they usually return of their own accord. Some herds may be driven like ordinary cattle. A small inclosure for a vicious bull elk should have a strong fence, 7 or 8 feet high. Mr. Russ tells us that where lumber for posts is cheap a good elk fence can be built for $200 a mile, but the actual cost will, of course, vary greatly, according to style, cost of labor, nearness to market, and other circumstances.

COST OF STOCK.

The cost of stocking an elk preserve is not great. Young elk in perfect condition may be bought for $100 per head or less. A few years ago Mr. Wilson, of Lewisburg, Ohio, paid $165 for 3 head. A Michigan breeder recently offered a dozen head, all fine specimens, but age and sex not given, for $500. This is, of course, a low price, not more than cattle would bring, and less than the venison would be worth if they could be sold in that form. The price of such stock is determined by the law of supply and demand, and as long as the present restrictions on the sale of deer and elk are maintained, low prices are likely to prevail. Live elk sold at forced sale have been known to net the owners less than $25 a head, but conditions would soon change if the laws concerning the sale and shipment of venison were generally made favorable for producing it in preserves. The demand for breeding stock would grow and increase the cost of starting, as well as the returns from the business.[a]

VICIOUSNESS OF THE MALE ELK.

Notwithstanding the viciousness of the male elk in the rutting season, he is ordinarily docile, probably more so than the buck of the common deer. Male elk have frequently been trained to harness and driven in public. Lorenzo Stratton trained a pair to harness and began exhibiting them at the Cattaraugus County (N. Y.) fair in 1853. They were a feature of the fair for several years, until he sold them in Europe. Exhibitions of trotting elks were common at county fairs in the Middle West a few years ago. W. H. Barnes, of Sioux City, Iowa, trained a pair and drove them harnessed to a light vehicle. He afterwards taught one of them to dive from a platform 30 feet high into a pool of water, and later he exhibited the animal in this act to admiring crowds in Europe.

The intractability of the male elk is not exceptional among deer kept in confinement, but his great size, his long, sharp-pointed antlers, and his thick skin, that renders him insensible to pain, make him much more formidable than the common deer. Several tragedies connected with attempts to domesticate the elk are matters of history. One recorded by Judge Caton occurred in his park.[b] Another took place at Bull City, Osborne County, Kans., October 12, 1879, in which Gen. H. C. Bull was instantly killed, two other men mortally wounded, and a fourth seriously injured by the attacks of an infuriated elk that had previously been regarded as tame and docile.

Deer and elk that are wild and unconfined will, under nearly all circumstances, run from man. When wounded they have been known to attack hunters; but it is unlikely that an uninjured wild bull elk would attack a human being even during the rut. The tame or partially tame animals that have become familiar with man are the ones to be feared. However, not all individuals become ill-tempered or vicious.

It should be borne in mind that all deer when confined in small inclosures and partly domesticated are likely to become dangerous whether they have antlers or not. They can strike a vicious blow with the front feet; and a strong man, taken unawares, may easily be disabled or even killed by a doe of the common deer. To overcome the tendency to bad temper in deer would require many generations of breeding under domestication. It can not be quickly eradicated by petting the animals; on the contrary, it is usually increased by overfamiliarity. Children and strangers should be excluded from parks and paddocks that contain deer known to be vicious. Special precautions should be taken during the rut and when does have very young fawns. Persons with whom the animals are familiar should be constantly on the alert against surprise. In the rutting season no adult male deer or elk, however mild he may be at other times, should be trusted.

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[a] Since the above paragraph was written Farmers' Bulletin No. 330, Deer Farming in the United States, has been issued, and an unusual demand for deer and elk for breeding purposes has developed. Consequently prices are considerably higher.

[b] The Antelope and Deer of America, p. 285, 1877.

The remedy for viciousness in the male deer is castration. This makes the animal docile. It is unsafe to keep an uncastrated male elk over 4 years old, except in a strongly fenced inclosure. If the operation is performed when the horns are fully developed, they will be shed at the usual time and a new pair will take their place, but will not fully mature nor lose the velvet.

Another effect of castration is improvement in the quality of the meat, just as in the production of beef, pork, and mutton. Venison grown in preserves under a system in which all the male animals intended for slaughter are castrated should be uniformly of the highest quality, far superior to that obtained in the wild state during the usual open season for hunting, which comes during the rut or soon after. This is of great importance in fixing the final status of venison grown in private preserves.

THE ELK AS AN ENEMY OF WOLVES AND DOGS.

The statement by Mr. Russ in his report on raising the elk in the Ozarks, to the effect that elk are enemies of dogs and wolves, is of more than passing interest. Judge Caton reported a similar animosity of his elk toward dogs, and stated that the does always led in the chase of dogs that got into the elk park. If it is true that these animals when umhampered by deep snow will attack and vanquish dogs and wolves and thus help to protect domestic animals grazing in the same pastures, a knowledge of the fact may prove useful to stockmen and especially to sheep growers. It should be of great advantage in changing from a system of herding to the use of fenced pastures for flocks.

It is doubtful whether the enmity of elk for dogs and wolves extends to the animals outside of fenced pastures. Ex-President Roosevelt in Outdoor Pastimes of an American Hunter reports having seen a coyote walking unnoticed among a herd of elk in Yellowstone National Park. Thomas Blagden, of Washington, D. C., informs the writer that elk taken from the Whitney preserve to Upper Saranac Lake in the Adirondacks always ran from barking dogs, and were frequently chased from the grounds of cottages near Saranac Inn by this means; but possibly the presence of men with the dogs had much to do with the fleeing of the elk.

THE WHITETAIL, OR VIRGINIA DEER.

Since the whitetail is the most widely distributed of American Cervidæ, there can be no question of its adaptability to nearly all sections of the United States. Testimony as to its hardiness in parks and preserves is not so unanimous as in case of the wapiti; but the general opinion of breeders is that with suitable range, plenty of good water, and reasonable care in winter the business of raising the animals for stocking parks and for venison may be made as profitable as any other live-stock industry. It has the advantage that land unsuited for cattle may be utilized in raising deer.

Advocates of the Angora goat industry state that in the United States there are 250,000,000 acres of land not suited for tillage nor as pasture for horses, cattle, or sheep, which are well adapted to goats. Much of this land is equally well suited to deer and elk, which do less injury than goats to the forest cover.

Probably experiments in domestication have oftener been made with white-tailed deer than with any other North American mammal. The great beauty of the young fawns appealed to the earliest settlers, who soon learned how easily they could be tamed and how readily they attached themselves to those who fed them. The danger from these same pets, especially the males, when grown, was soon learned also. Thus the experiment usually ended with the maturity of the subject, which was soon disposed of or banished to a safe inclosure.

Deer parks were established in early times on a considerable number of the large estates, or manors, in Maryland, Virginia, and New York. At least one of those in Maryland dated back to the seventeenth century. The early parks seem to have been generally stocked with fallow deer brought from England. The Revolutionary struggle marked the destruction of nearly all the private deer preserves; but a few of them, especially in Maryland, continued in existence, and others were restocked after the end of the war. As few fallow deer were imported later, and it was generally believed that our native deer were unsuited for park purposes, private preserves did not become numerous. The common opinion as to native deer was expressed by the eminent authority on landscape gardening, A. J. Downing, who in 1852 wrote as follows:

> **All attempts to render our native deer really tame on home grounds have, so far as we know, failed among us, though with patience the thing may**

doubtless be done. It would be well worth while to import the finer breeds of English deer, which are thoroughly domesticated in their habits and the most beautiful objects for a park.[a]

When the above was written, both Virginia deer and American elk were doing well in a number of parks in the United States, and had been acclimatized in parks in England and on the Continent, where they were almost as tame and fully as hardy as the fallow deer. That these facts should have escaped the notice of Mr. Downing seems remarkable.

The American Turf Register and Sporting Magazine for April, 1831, contains a letter from W. E., of Roanoke, N. C., in which he gave interesting details concerning his herd of domesticated deer. These he claimed were so tame that his hounds readily distinguished their track from those of wild deer that occasionally visited the park. He wrote in part:

> One-half of my park being a forest, the deer shelter themselves in it during bad weather, and they dislike cold so much that frequently they will not leave their shelter to come to the troughs, which are in an unprotected part of the inclosure. To prevent fights there should be at least one trough for every two deer. I feed them on Indian meal, having found by experience that raw corn is apt to swell and kill them. One quart of meal per day is sufficient to keep a deer always fat. They are very fond of sweet potatoes, which they will eat though half rotten; they like the leaves but not the root of turnips.
>
> Deer are very prolific. I have never owned but two does that had less than two fawns at a birth. A friend of mine owned a doe that had three fawns three years in succession and they were all females. * * *
>
> I have known but one doe to have fawns before she was 2 years old. * * * They generally bring forth from the 1st to the 20th of June. The earliest that I have known was the 18th of May and the latest the 12th of July. Should a doe die leaving fawns, one of the other does attends to the fawns as well as if they were her own. Just before the time for them to have young, I put them up in six-sided pens made of rails. The fawns at first are quite wild. I do not have them turned out of the pens before they are perfectly gentle.

The raising of deer for profit has seldom or never been undertaken in a systematic way in the United States. Breeders have stocked preserves with deer as game for private use or grown the animals in small inclosures for the pleasure of owning them. But the economic possibilities are now beginning to be apparent. Some who have abandoned the business for lack of proper range are yet convinced that it might be made profitable. From a mass of correspondence, the writer has selected the experiences which bear most upon economic results and upon the proper management of the animals in semidomestication.

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[a] Rural Essays, p. 174, 1854.

EXPERIENCES OF BREEDERS.

While hunting in the Adirondacks in 1874, Thomas Blagden, of Argyle, near Washington, D. C., captured a pair of fawns and took them to his home. In due time these deer bred and became the ancestors of several hundred head. In 1902 Mr. Blagden transferred 48 of his herd to his summer home at Saranac Inn, Upper Saranac Lake, in the Adirondacks. (Plate VII.) On account of insufficient range and food, both herds have been greatly reduced by sales, and the greater part of the Argyle herd has been destroyed by worthless dogs.

Mr. Blagden is confident that under proper conditions the business of raising deer may be made to pay well. In his own herd, by securing new bucks from time to time, he has carefully avoided continued inbreeding. His stock is vigorous and of the large size characteristic of the Adirondack and other northern deer. On this account they command an exceptionally high price, $50 each for bucks and $75 each for does. He feeds grain, using corn, and a mixture of bran and meal. During the summer as much wild food as possible is cut for the deer, which always care more for the rankest weeds than for the choicest grass. Of hays they prefer alfalfa to other kinds.

Mr. Blagden regards the water supply of a deer park as extremely important. Running water should be constantly accessible to the animals. He attributes the great winter mortality among wild deer in the Adirondacks entirely to the fact that all water courses are frozen solid, and to obtain water deer are forced to eat sleet-covered shrubbery, which, he thinks, poisons them.

W. R. McKeen, of Terre Haute, Ind., has a large herd of deer on his stock farm near that city. The Sportsmen's Review quoted an account of this herd from an Indianapolis newspaper stating that it is one of the largest, if not the largest, herd of near-domesticated deer in the State. The herd was started nearly twenty years ago with about half a dozen animals and with no idea of profit. With the exception of a few dairy cows, no other stock is now kept on the farm. The demand for deer is fairly active. Each fall a considerable number are sold, and shortly before the Christmas holidays of 1906 between 30 and 40 were disposed of. The deer are sold to persons having parks of their own and to museums, menageries, and the like. There is also a demand each winter for venison. Altogether the sales keep the increase of the herd from overstocking the place.[a]

Writing March 28, 1908, John W. Griggs, of Goodell, Iowa, states that he has been engaged in raising deer about fourteen years. Until two years ago he sold his surplus stock for parks, but since then has

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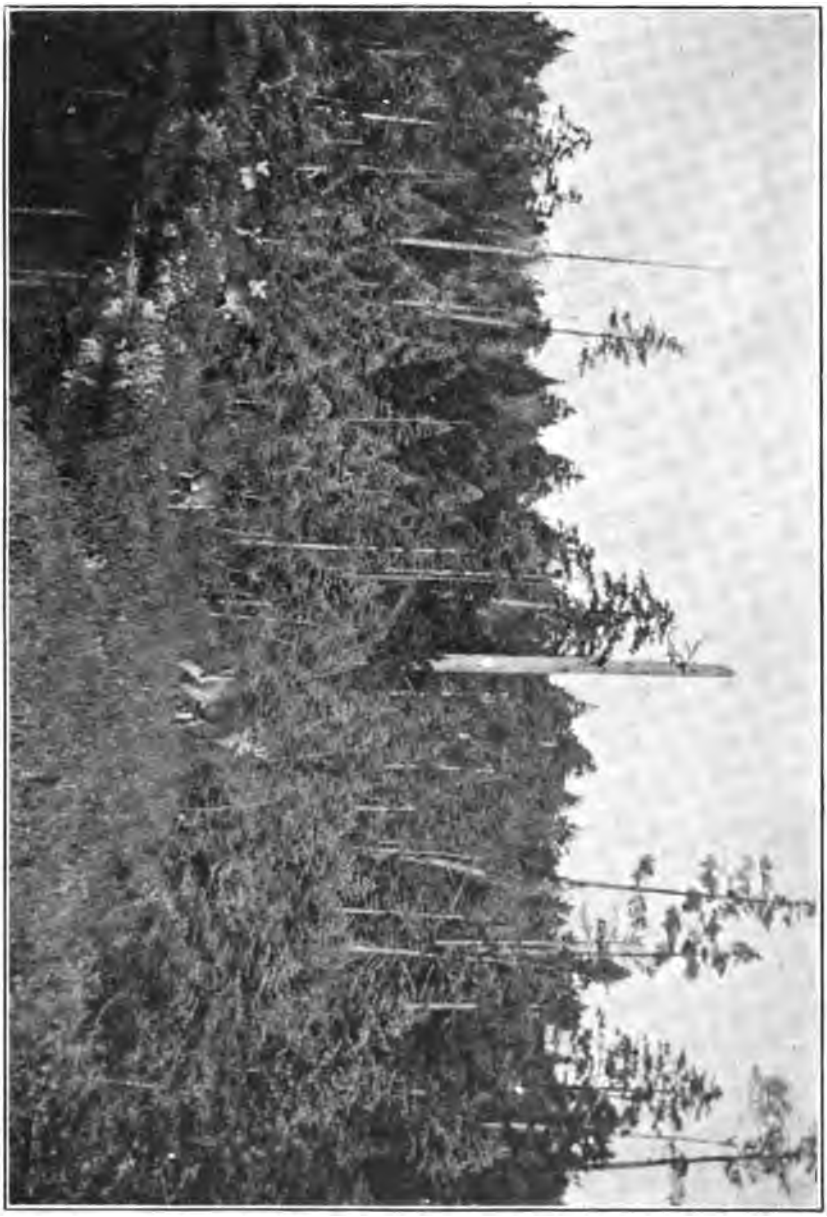
[a] Sportsmen's Review, XXXII, 286, Sept. 14, 1907.



VIRGINIA DEER IN PARK BELONGING TO THOMAS BLAGDEN, SARANAC INN, UPPER SARANAC, N. Y.

disposed of about half of it for venison. For park purposes he gets $20 to $30 a head; when fattened for venison they bring $20 to $35 a head. The animals do well in captivity. Mr. Griggs says further: "In raising a large herd the park should be divided into two or three lots, and one plowed each year and sown to red clover, mustard, rape, and seeds of different kinds of weeds. Blue grass and timothy are useless. Corn is the principal grain I feed. I feed it winter and summer. In winter I feed also clover hay, oat straw, and weedy wild hay. Deer when rightly handled are very prolific, and from 50 does one can count on 75 fawns. Deer can be raised profitably for venison—very profitably until overdone—but I would not advise one to go into it on a large scale without previous experience with deer."

Charles Goodnight, of Goodnight, Tex., writing March 26, 1908, states that he kept deer and elk on his plains pastures for a number of years, until he became convinced that his ranch was unsuited to browsing or partly browsing animals. He says: "With a properly selected place, the raising of these animals is not only practicable but very profitable. I should select a rough, broken piece of country with some prairie and glades, covered with as great a variety of shrubbery as possible. Deer will not eat ordinary grass if they can help it, but will eat wild rye and other kinds of soft grasses. With a properly selected place they are of very little expense after the pasture is fenced."

R. H. Harris, of Clarksville, Tex., on January 16, 1908, wrote that he had been engaged in raising Virginia deer for several years, and thinks that the business is admirably adapted for the profitable investment of capital. The Virginia deer is suited to almost every section of the United States. It is prolific, each doe usually producing twins. These grow very rapidly, and become the most beautiful, graceful, and healthy animals known. The demand for venison and deerskins is unlimited, the flesh being very high priced in city restaurants and cafés.

"No other meat," says Mr. Harris, "is equal to venison as a diet for the sick, it being easily digested and agreeing with the most delicate stomachs. Deer are easily tamed; the wildest fawn, if taken from the herd when young, will in a few hours become as gentle as a pet dog. I have for several years been raising them in large numbers. They run at will in woodlands and fields, are never handled, but fed occasionally, and are as gentle as a common herd of cattle. They are easily and cheaply raised and seldom, if ever, die from natural causes. After years of practical experience, I unhesitatingly state that the raising of deer is in profitableness second only to the raising of cattle.

"The cost of feeding deer averages about one-half cent each per day. They feed on all kinds of vegetables, buds, and leaves of trees, growing wheat, clover, peas, barley, oats, etc. Cotton seed is also a very cheap and satisfactory food for them. They eat also corn, bran, chops, fruit, and in fact anything that man or beast will eat, except dry hay. They live from twenty to twenty-five years. They are easily confined by a woven wire or barbed wire fence, 6½ feet in height."

A DOMESTICATED HERD OF DEER.

C. H. Roseberry, of Stella, Mo., writes under date of January 13, 1908, as follows:

My experience in breeding the common or Virginia deer covers a period of seventeen years, beginning in March, 1891, when as a boy of 16 I built a small inclosure of 1½ acres to confine a single doe that was captured as a fawn in the neighboring forest. A buck and other does were secured from year to year until in 1900 by purchase and natural increase my herd numbered 25 head of all ages.

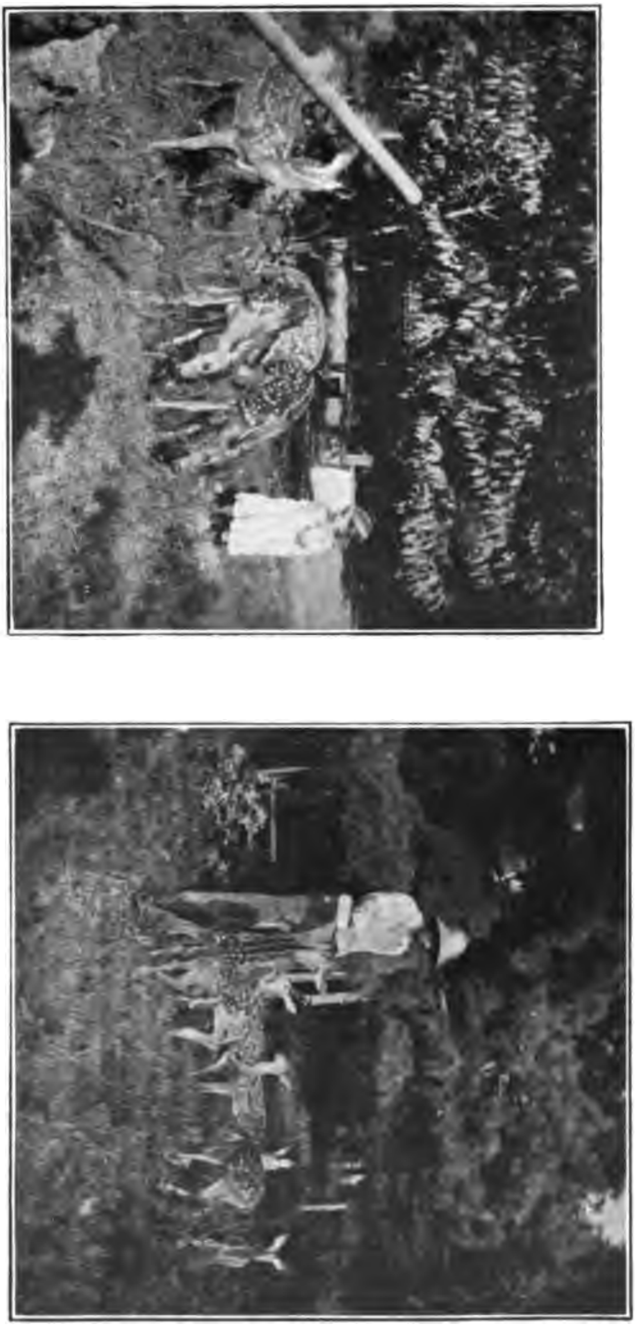
From 1891 to 1901 I lost every year from disease an average of 20 per cent. The climax came in the drought year of 1901, when my loss was 50 per cent from the disease known as "black tongue." I am convinced that, as with cholera in swine, individuals recovering from this disease are immune from further attack. Apparently all of my herd were afflicted. The survivors and their progeny constitute my present breeding stock. I have made no purchases since 1901, nor have I suffered any loss from disease.

For the last seven years my herd has averaged 70 per cent increase, all of which I have sold at satisfactory prices. I began selling at $20 per pair of fawns at 4 months of age and $30 per pair of adults. I now get $40 and $60, respectively. I sell almost exclusively for pets and for propagating purposes, although a few surplus bucks have been sold for venison, averaging me 15 cents per pound gross weight.

If we except the goat, I know of no domestic animal common to the farm that requires so little feed and attention as the deer. My herd has a range of only 15 acres, two-thirds of which is set to white clover, blue grass, and orchard grass. I provide also a small plat of wheat or rye for winter pasture. With the above provision in this latitude no feed is required between April 15 and November 15. During the rest of the year a ration of corn, bran, or other mill feed, somewhat smaller than that required for sheep, in connection with a stack of clover or pea hay to which they have free access, is sufficient to keep them in good condition. Deer eat with relish nearly all of the common coarse weeds, and for clearing land of brush they are, I think, second only to the common goat.

Probably the greatest expense connected with the business of raising deer is the fencing. Another item of trouble and expense when the animals are raised for pets, requiring that they be handled and shipped alive, is the fact that the fawns must be taken from the does when 10 days old and raised by hand on cow's milk. They are quite easily raised in this way, with but slight percentage of loss, but require frequent and careful attention for the first month. (Plate VIII.) When they are allowed to run with the does their natural wildness can not be overcome, no matter how gentle the does may be. (Plate III, fig. 1.)

I have found the business profitable on the lines indicated. I believe they could be profitably bred for venison alone, certainly with less trouble and expense, since the fawns would be reared by the does and the trouble and expense of raising by hand eliminated.



FAWNS OF THE VIRGINIA DEER AT KENT DEER PARK, HOME OF C. H. ROSEBERRY, STELLA, MO.

My experience does not coincide with that of some other breeders in respect to the weakening of reproductive powers of deer by their confinement in parks.[a] I have no barren does. Usually they produce a single fawn at 2 years of age; afterwards twins, and, in rare cases, triplets.

INCREASE OF WHITE-TAILED DEER IN DOMESTICATION.

Early in 1900 a pet doe heavy with fawn was delivered at the Taney County, Mo., game preserve belonging to the St. Louis Park and Agricultural Company. The doe had been thoroughly domesticated, and, refusing to join the wild deer in the preserve, remained near the home of the tenant and under the immediate care of his family. In the spring of 1900 she gave birth to two fawns, both does, which became as gentle as the mother. In the spring of 1901 the old doe again dropped 2 fawns. In 1902 there was an increase of 4 fawns, each of the young of 1900 having given birth to a fawn. By the spring of 1905 the domestic herd had increased to 25 deer, all the increase of 1 pet doe.[b]

A herd of mule deer at Crawfordsville, Ind., has increased with almost equal rapidity. These deer belong to James F. Boots, and are kept in a 4-acre inclosure. Mr. Boots writes that in 1899 he brought a buck fawn from Colorado, and nearly four years later he secured 2 adult does. From this stock he has had fawns as follows: 1904, 4; 1905, 4; 1906, 8; 1907, 10; 1908, 5; 1909, 10; from the 5 does then kept. All were raised except those born in 1908, the loss of which was attributed to excessive heat.

DEER HYBRIDS.

However undesirable hybrids among wild animals may be regarded by naturalists, the production of them among domesticated or semidomesticated species is of great economic importance. The experiments of breeders in hybridizing deer, aside from the apparent value of the results obtained, are highly interesting. Mention has already been made of hybrids between the American wapiti and the red deer as well as the Altai wapiti. The first of these crosses was obtained by the Prince of Pless, in Silesia, about a half century ago.

Judge Caton made experiments at Ottawa, Ill., and obtained a number of hybrids, the most important being those between the Virginia deer and the Acapulco deer (*Odocoileus toltecus*) and between the Virginia deer and the Ceylon deer (*Cervus axis*). These deer exhibited no natural tendency to breed together, but when the male of the exotic species was absent or accidentally lost he introduced the buck of the Virginia deer.

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[a] Cf. Caton, J. D., Antelope and Deer of North America, p. 304, 1877.

[b] Second Annual Report Missouri Game and Fish Warden, p. 20, 1907.

John W. Griggs, of Goodell, Iowa, has succeeded in crossing the mule deer with several races of the whitetail. The hybrids were obtained by isolating the pairs in separate yards. As long as the different species or races are kept in a common pasture, each kind herds by itself and no sexual association between the different kinds takes place. Under such circumstance or in the wild state crosses are exceedingly rare. Mr. Griggs obtained his hybrids by placing a buck of the mule deer with whitetail does before the rut began, and the offspring proved to be highly satisfactory as to size and stamina, and also were perfectly fertile. As was to be expected, however, offspring in the second generation of hybrids varied much in form, size, and other characteristics, and on the whole were not so satisfactory as the first generation. He thinks that his hybrids with the mule deer have stronger constitutions than the Virginia deer and are less liable to disease.

Charles Goodnight, of Goodnight, Tex., writes that he crossed the mule deer with the white-tailed deer with great success, making a valuable and beautiful animal with greater size and better meat than the common deer. The hybrids were fertile also, and Mr. Goodnight would have continued his experiments further, but, having no shrubbery or trees within his range, he found it unsuited to deer and liberated his herd.

HABITS AND MANAGEMENT OF VIRGINIA DEER.

Deer are polygamous like cattle. The rutting season is in November, the period of gestation is 205 to 212 days (about seven months), and the fawns are born in May or June. The young does breed usually when about seventeen months old, and have but one fawn the first time; afterwards they commonly have twins. The fawns are spotted, and remain so until the hair is shed in the fall.

The white-tailed deer is even more a browsing animal than the elk; and yet it can and often does manage to get along in summer on grass alone. In a cultivated pasture it eats rank weeds and wild grasses in preference to timothy or blue grass. Observation of deer feeding in a pasture several hundred feet away is insufficient to determine accurately what they are eating. A writer in The American Field states that he often saw mule deer apparently eating grass in the Colorado parks, and he had no doubt that they did so until a hunter informed him that they would not eat grass unless they could obtain no other food. Afterwards he had a number of times examined the stomachs of deer he had killed, and only once found what was unmistakably grass.[a]

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[a] American Field, XXII, 609, Dec. 27, 1884.

The Biological Survey has examined a few stomachs of deer killed in the United States. A Columbia black-tailed deer taken in the Chemise Mountains, Mendocino County, Cal., had eaten acorns and an equal bulk of foliage, mostly willow leaves. A young deer of the same species taken on Mount Shasta, California, had grass in its stomach. Three individuals of the Arizona race of white-tailed deer (*Odocoileus virginianus couesi*), taken at different times, had eaten, respectively, leaves of the little blue live oak (*Quercus grisea*), with some flowers and flower stems of *Nolina lindheimeriana;* green foliage, seeds, berries, and the pods, beans, and leaves of *Acacia* sp.; and green leaves of *Thermopsis montana*, vetch, strawberry, geranium, *Senecio* (two species), aspen, and a flat green lichen—no trace of grass or acorns. A white-tailed deer killed in Minnesota in April had nothing but lichens in its stomach.

In captivity deer eat almost every kind of vegetation, including all sorts of garden stuff. They are fond of acorns, beechnuts, chestnuts, and other mast. Lily pads, fallen leaves, lichens, and mosses are freely eaten; so that, with plenty of range and an abundant variety of plants, there is little difficulty about food for deer. A good supply of running water must be provided, and the animals should have access to rock salt. If the browse and pasture are scant, some grain should be fed even in summer, and it is best to feed regularly in winter. Of the grains, corn is generally recommended; there is no waste in feeding it, as deer pick up every grain. Coarse hay full of weeds is preferable to timothy or other tame hays, except alfalfa. Of clover hay, deer usually pick out the dry flower heads greedily, but waste the other parts. In the northern half of the United States winter shelter should be provided for deer.

The practice of pasturing hogs in deer parks is objectionable, since they destroy nearly all the mast. For this reason the wild boar is unsuited for American game preserves intended for deer and wild turkeys.

VICIOUS BUCKS.

The dangerous character of some deer, especially the males, in semidomestication has already been discussed. The whitetail is no exception. Charles C. Worthington, writing to the Biological Survey of his experience with vicious bucks, says:

> The first serious difficulty I experienced, and one the gravity of which should not be lost sight of by anyone starting a preserve, was with the tame bucks at the rutting season. These bucks from being tame and docile would become at this season fierce and dangerous. They would attack anyone at sight, even a person on horseback or in a wagon. Some of the gamekeepers had narrow escapes from being killed; in one or two instances being seriously injured. A pedestrian's only chance for escape was to climb a tree. Those bucks which developed this ferocity had to be systematically hunted and shot on sight.

Those left were the ones that had not been originally tamed, and not being accustomed to the sight of man, had not courage enough to make an attack. My experience is that a wild buck, even in the rutting season, still retains his natural fear of man, and, except when wounded, is never dangerous.

Instances of fatalities from attacks of vicious bucks of the Virginia deer are not lacking. A rather recent one was the death of Herbert Bradley at Montclair, N. J., November 10, 1906. While working alone on his grounds, he was attacked by a pet deer and so badly wounded that he bled to death before aid could be obtained.

The remarks about castrating the elk apply as well to the common deer. A number of vigorous bucks, however, must form a part of any considerable herd, for a single buck can serve only a limited number of does. One buck for each ten or twelve does will probably be enough. New bucks should frequently be introduced to avoid inbreeding.

CAPTURING LIVE DEER FOR SHIPMENT.

In 1887 C. W. Marsh, of De Kalb, Ill., in a letter to The American Field, said:

> Thirteen years ago this spring I fenced in a few acres of natural woodland with a bit of prairie adjoining my residence lot for deer; the fence was 8½ feet high and proportionately strong. I advertised for deer, and during the season got a buck from Sioux City, caught in Dakota; a doe from Kansas; another from Missouri; and still another from a gentleman in De Kalb, this last having been sent to him when a fawn from Arkansas. They were all red or Virginia deer, but showed considerable difference in size, form, and disposition; and they were all tame; that is, had been pets and would bear handling; hence had come quietly and unharmed in their cages. These began breeding at once, the does dropping two fawns generally. The young deer were as wild probably as any in the forest at first, but as the does were tame they also soon became quite tame, though not one has ever submitted to handling. They were rugged, hearty fellows, and in course of a few years I had a herd of over twenty. Occasionally I killed one for venison, and as they increased so fast I caught and gave a number to friends and sold a few. While the old does lived the young were easily caught, as the former would go into any cage or trap for food during the winter months and the latter would follow, and although they would struggle fiercely when caught, they gave up and quieted down as soon as hands were removed. None were lost in shipping. In due time the old does died, and all of my present herd except one buck were dropped by does that were bred in the park. Apparently each succeeding generation became wilder and more difficult to catch, and I have for some few years past thinned them out in the fall by shooting and marketing them. Still, they always answer my whistle and come around me for food. * * *
>
> They are hardy, active, and very shy of anything strange, but manifest strong attachment for home. Several times during these many years dogs have gotten into the park and run some of them out. When scared thus, nothing will stop them, and they will either go through or over any fence—they have frequently bounded over mine, 8½ feet high—but when out they will usually jump back again of their own volition, even though they had been off in the woods or about the park outside for weeks. In such instances they hung

around for a time seeking an easy entrance apparently (it is useless to try to drive them in), and failing in that they finally jumped over or smashed through the fence. When out they are very wild, but when they get in will come up for feed and be as tame and unconcerned as before.

As a culmination to the increasing wildness of his herd, Mr. Marsh found that in capturing and crating deer which he sold for stocking purposes he lost a large per cent as a result of exhaustion from their struggles.[a] Mr. Blagden relates a like experience in shipping live deer to purchasers, but later he overcame the difficulty by an ingenious trapping device. Charles C. Worthington uses a similar trap at his Warren County (N. J.) preserve.

In a recent letter to the Biological Survey, Mr. Worthington describes his deer trap as follows:

> As a demand exists for deer to be used for the restocking of state lands and for establishing private preserves, I, several years ago, began experiments in trapping them. It was well known that a wild deer caught in any small inclosure of wire will kill himself in his efforts to escape, but believing that he would not do this if the fence were made in such a way as to prevent his seeing through it, I constructed an oblong trap, about 20 feet wide and 30 feet deep, of boards 10 feet high, nailed closely together, so that nothing could be seen through them. A board door of the same height and running loosely in vertical grooves was fitted to one end, and opposite to it a narrow board passageway was built just high enough for a deer to enter and about 5 feet long; at the outer extremity of this passageway was placed a similar sliding door, big enough to close tightly the end of the passage. The main door is held open by a wire that extends several hundred feet to a blind, where the trapper stands concealed. When the snows are on the ground, this trap is baited with tempting food, which the deer finally enter the trap to secure. When it is found that they enter the trap without hesitation, a man stations himself on watch, and at such time as a number of deer are inside, drops the sliding door and imprisons them. They are left for a few hours until their first fright is somewhat allayed. Then crates, just large enough to hold one deer, and having only enough openings to supply sufficient ventilation, are placed, one at a time, in front of the smaller sliding door at the end of the passage. The crates are provided with a corresponding door. These being raised, the deer are made to enter the crates one at a time, and so are secured. The men, during this entire operation, remain concealed.
>
> This form of trap has proved effective and satisfactory in every way. There have been caught in it during the last few years over 300 deer, which have been transferred to various localities throughout the country with a death rate of less than 4 per cent. The trapping operations have to be discontinued by the middle of February, owing to the does being then so heavy with fawn that any attempt to crate and transfer them is attended with too much risk.
>
> The game commissioners of Pennsylvania and New Jersey have purchased numbers of these deer to be liberated in various parts of their respective States. The experiment of restocking districts from which these animals disappeared long ago has proven most successful and popular.

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[a] American Field, XXVII, 295, 1887.

WILD DEER IN PRIVATE PRESERVES.

In many parts of the United States private preserves have been established by either individuals or associations and stocked with deer and other big game. Such enterprises have met opposition from both citizens and sportsmen, the latter being frequently ousted from favorite hunting grounds by the fencing and posting of such preserves. The feeling against large deer parks in America is in part a survival of an Old World prejudice against them, but in the main results from doubt of the wisdom of permitting large holdings of unproductive land. In a majority of the States private preserves are still subject to all the game laws of the State, so far as time and manner of hunting in them are concerned, and thus the owners are unable to reap the full economic advantage of their possession. While these conditions prevail, large game preserves are open to the objection that they are sources of wealth which are not fully utilized.

A few private preserves have been stocked with exotic game—red deer, wild boars, and the like—and in many of them large expenditures have been necessary to provide good sport. In some of the States the rights of owners of such preserves to the unrestricted use of the game within them is not clear, while such rights are clearly set forth or denied in the laws of others. As long as game within the preserve is comparatively scarce, owners will be content to use it in strict conformity to the hunting laws of the State. But when the game increases so as to overstock the preserve, or to become a source of revenue to the promoters, greater privileges will be demanded and will have to be granted, for grades of domesticity in deer and elk are not sharply drawn, and there is no difference, so far as ownership is concerned, between those raised in parks for venison and those produced in a fenced preserve for sport.

Full recognition of private ownership in game does not interfere with the right of the State so to regulate its disposal as not to jeopardize the preservation of wild game. Game regulations must be insisted upon, and the owners of private preserves will usually be as vigilant as anyone in helping to enforce them.

The increase of white-tailed deer, when protected within suitable large fenced preserves, is remarkably rapid, and there is no doubt as to success in propagating them under natural conditions as wild game. The experience of a large number of hunting clubs and individuals that have stocked preserves is favorable. In the ten years between 1892 and 1902 deer in Buckland Park, the Warren County, N. J., preserve belonging to Charles C. Worthington, increased from 19 to about 400 head, a number considered too large for the sustaining capacity of the park. The St. Louis Park and Agricultural Company have about 1,000 deer and 400 elk on their large preserve in Taney County, Mo. About six years ago the Otzinachson Rod and

Gun Club, of Clinton County, Pa., placed about 90 deer, mostly does, in their 4,000-acre park. These have multiplied to nearly 2,000 head, and a further increase of about 1,000 fawns was expected during the season of 1908. These experiences in stocking large preserves with deer, although highly successful, are probably not exceptional.

EFFECT ON GAME SUPPLY.

The effect of private preserves on the supply of game in the State should not be overlooked. While they may temporarily restrict the hunting privileges of a few citizens, ultimately they become a source of game supply secondary in importance only to state preserves. Already a number of private preserves have become overstocked, and game has escaped or been turned out to become the property of the people. Both deer and elk are said to have escaped from the Corbin preserve in New Hampshire and from the Whitney preserve in Massachusetts. The game in the well-stocked preserve of Dr. W. S. Webb in the Adirondacks became the property of the State when, in 1903, the owner demolished the fences which for many years had surrounded his 8,000-acre park.

Charles C. Worthington writes, May 21, 1908, that when, in 1902, the deer in his New Jersey preserve became too numerous to be supported by the acreage inclosed, several wide gates were left open for a few months. Few of the animals availed themselves of the opportunity to escape. Mr. Worthington says: "There was little incentive for them to leave the inclosure, and most of those that did probably returned at the first alarm, their instinct directing them to the inclosure as a protected, safe retreat. The few that remained outside have increased in numbers, until now the region round about for a radius of several miles is well stocked. While some complaint has been made by the farmers in the neighborhood that the deer destroy some of their grain, the general sentiment is in favor of having the laws for their protection rigidly enforced."

The success of private enterprise in propagating deer in inclosures is an object lesson for state game commissions and others, and suggests that the State should undertake similar work for the public. The establishment of game preserves on public lands of the State is a most important step in game preservation, especially if the lands are already stocked with wild deer. But the further introduction of breeding animals will hasten multiplication, until the preserve becomes a source of game supply for the surrounding territory. While more national preserves are needed, a system of state preserves is all-important. Those already established in Pennsylvania and other States have proved highly useful, and it may truthfully be said that in every country that has tried them, public game preserves have been instrumental in increasing the game supply.

GAME PROPAGATION AND GAME LAWS.

The chief obstacle to profitable game propagation in the United States lies in the restrictive character of state laws affecting the killing, sale, and transportation of game. Many of the States, following precedent, lay down the broad rule that all the game in the State, whether resident or migratory, is the property of the State. A few of them, notably Nebraska, North Dakota, and Tennessee, except such game animals as are "under private ownership legally acquired." A few others encourage private ownership by providing means by which wild animals may be captured for domestication. Generally, where private ownership of game is recognized by law, the right to kill such game is granted, but the owner is hampered by the same regulations as to season, sale, and shipment that apply to wild game. One by one, however, state legislatures are coming to recognize the interests of game propagators and to modify the game laws to meet the changed view.

TRANSPORTATION OF LIVE DEER.

Except in a few States that provide for the capture of wild deer under permits, the only source of stock for private preserves is the animals already in captivity. Hitherto the shipment of live deer and elk from private preserves has often been permitted because game wardens and others interested could see no advantage from interfering, notwithstanding that a literal construction of the law in many States would absolutely forbid such shipments. Pennsylvania is one of the few States that give owners of private deer preserves the positive right to sell and ship deer or fawns at any time for propagating purposes.

TRANSPORTATION OF VENISON.

Under the license system and within specified limitations, some of the States permit the holder of a hunting license to ship venison lawfully killed to his home within or without the State. The general transportation of venison, as well as its export out of the State in which it was killed, is usually forbidden. Only a few States permit the export of deer, and two of them—Delaware and Ohio—have no deer, so that the animals are not mentioned in recent game laws of those States. The laws forbidding export usually specify deer or parts of the carcasses of deer; so that the legal shipment of live deer is impossible except in States which make provision for their export for propagating purposes.

Before 1909 the two sections in the game law of New York referring to the killing and sale of deer specified "wild deer," but in the section relating to transportation the word "deer" was unqualified. The manner in which this omission at first affected the owner of a private preserve is illustrated by the decision rendered in 1907 in the case of Dieterich *v.* Fargo.[a]

The American Express Company refused to receive and transport deer raised and killed in a private preserve in Dutchess County. The owner of the herd, Charles F. Dieterich, found it necessary to kill some of the bucks each year and ship them to New York for sale. On the refusal of the express company to transport his venison, he applied for a temporary injunction against its president, James C. Fargo, claiming that the law prohibiting transportation did not apply to domesticated deer. The supreme court of New York County, in December, 1906, decided in favor of Dieterich. This decision was reversed by the appellate division of the supreme court of the State, May 10, 1907, by a majority of the court. The opinion by Justice O'Gorman was to the effect that the section of the law prohibiting the transportation of deer from one county to another, and requiring express companies to refuse to accept deer when not accompanied by the owner, applied to domesticated as well as to wild deer. The transportation of deer raised on a private preserve was held to be subordinate to the police power of the State. One of the dissenting opinions held that Dieterich had the same natural and legal right to fence his farm and devote it to the propagation of deer that he had to use it for raising cattle or sheep.

To market his deer in 1908 Mr. Dieterich resorted to the novel expedient of paying transportation for a number of men in the city of New York to go to his country preserve, each shoot a deer and accompany the carcass to market, as required by the law. However, the New York court of appeals finally, February 23, 1909, reversed the decision of the lower court and held—one of the six judges dissenting—that the law concerning transportation of venison did not apply to that from domesticated deer bred in confinement, and that the owner of such deer was not restricted as to the number he may kill and ship during the open season. The law regulating transportation of venison has recently been amended to provide for shipment from private preserves.

As would be expected by those familiar with the history of British deer preserves, the laws of the various Canadian Provinces are in general more liberal toward the owners of private deer parks. The general tariff law of Canada permits the export of any home-bred deer under regulations made by the Governor General in Council.

KILLING DEER RAISED IN PRIVATE PARKS.

The failure to except deer kept in private preserves from the operation of the laws providing a close season for wild deer prevents the owner of deer from using the venison for food in his own family.

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[a] 102 N. Y., Supp. 720.

He is restricted to a very short open season at a time when, on account of the rut, the animals are least desirable for food. If permitted to sell the venison, even in his own State or county, he must do it during the same limited period, when, owing to the presence of wild game in the market, he may be compelled to accept an extremely low price. To make the business of growing venison profitable, the grower must be able to choose his own time for marketing the product, as in case of beef or pork.

SALE OF VENISON.

In more than half the States and Territories the sale of venison from private preserves is illegal at all times, and until recently the sale was illegal in nearly all the States. Several States now forbid the sale of venison produced within them, but permit the sale of that imported from other States, a most unjust discrimination against home industry.

A recent experience in Pottawattamie County, Iowa, illustrates how the law sometimes affects private ownership of deer. The facts are gathered from newspapers, but in the main have been verified by correspondence. J. Cuppy, of Avoca, owned a herd of 20 deer, but died a few years ago without direct heirs and without having made provision for the deer, which had escaped from their inclosure. The administrators could not catch the animals nor lawfully kill them. The herd has increased to nearly 200 head of partly wild deer. They forage on the farms and gardens of the neighborhood, doing some damage, especially to stacks of alfalfa and corn shocks. No one may legally kill them, and prosecutions promptly followed when the county officials learned that a few of them had been shot and converted into venison.

The decision in the case of the State of Missouri *v.* Weber (102 S. W., 955) further illustrates the tendency of courts to give a literal interpretation to laws in order to uphold police regulations concerning game. Eight deer, from which the evidences of sex had been removed, were exposed for sale in the Kansas City market. They had been raised on a stock farm in Henry County, and came from a tame herd which had been in possession of the owner for twenty-five years. They were kept with cattle in a pasture surrounded by a high fence. The animals were never hunted, but the owner had been accustomed to kill several of them every year for sale in the Kansas City market. Defendant Weber was arrested and tried in the Jackson County criminal court in December, 1906. The defense was that the law did not refer to tame but to wild deer. The defendant was found guilty, and appealed his case. It was transferred from the court of appeals to the supreme court, which in its decision upheld the lower court. The court held that the law applied to tame deer as well as wild, and further that the act did not violate the constitutional prohibition of taking private property for public uses without compensation.

George S. Good, of Lock Haven, Pa., wrote in April, 1908, that deer had multiplied so rapidly in the preserve belonging to the Otzinachson Rod and Gun Club that the annual increase would soon reach about 1,000 animals. He thought the time not far distant when the club would be compelled to market or dispose of 1,000 deer each year to prevent overstocking the preserve. But at that time the law of the State did not permit the club to sell these animals except to stock other preserves; neither could they be killed except in strict conformity with the laws of the State concerning wild deer. Each of the 14 members of the club or guests of the club could take one deer in the open season.

If the surplus animals from large preserves like that just mentioned could be turned into venison and sold judiciously, they would become a source of steady revenue. A thousand adult deer marketed when the time is favorable should yield a gross income of nearly $25,000 a year. The Pennsylvania legislature of 1909 passed a law providing a means by which venison from private parks may be sold in the open season.

Attorney-General Atkinson, of Washington, in 1906, delivered an opinion concerning game raised in captivity, part of which is of interest in this connection:

> It is a well-known principle of law in States generally that wild birds or animals which have been kept in captivity and have become more or less domesticated, when reclaimed by the art and power of man, are the subject of qualified property, and are, as a general rule, under the protection of the law the same as any other property, and are at the disposal of the owner for using or selling as he desires. This seems to have been the law for thousands of years in civilized countries, and it would seem to have been the sensible principle to follow; for without doubt all animals and birds were once wild in feræ naturæ state, and by the application of this principle all people have tamed and acquired domesticity in animals and fowls from the game state, from elephants and horses and cattle down to chickens and canary birds.
>
> It is my opinion that our laws in this State covering the subject were intended by the legislatures to relate strictly to game, meaning animals and birds in their wild, free, roving state, and these statutes were not intended in any manner to limit or prevent any probable or possible occupation or industrial development relating to the growing and raising and domesticating of any kinds of birds or animals for food products and the general use of the people.

STATE LAWS THAT RECOGNIZE PRIVATE OWNERSHIP OF DEER.

Recognition of the rights of private ownership in deer and other big game is now given in laws of the States named below. It will be observed that most of the provisions were enacted recently.

Arkansas.—"Nothing in this act shall be so construed as to prevent any person or persons from having in their possession or buying or selling or shipping or any railroad from receiving for transportation any deer or fawn when such deer or fawn is raised in captivity for domestic purposes and is accompanied by an affidavit from the raiser to this state of facts." (Acts of 1907, No. 43.)

Colorado.—No one may maintain a private fish or game preserve for profit without taking out a license to do so. Owners of licensed private preserves are permitted to sell and ship deer or other quadrupeds, if the carcasses or live animals are accompanied by proper invoice and a permit from the state game and fish commissioner. A fee is charged for the license and for each animal shipped by permit. (Laws of 1899, ch. 98.)

Florida.—An act passed in 1909 protects private preserves from trespass. Such preserves are limited to 640 acres, and must be carefully posted. The game in them may not be killed for three years, and thereafter only in compliance with the general hunting laws of the State. (Ch. 5940.)

Illinois.—" Provided, that any person who breeds and raises deer for market, where the same has been bred and raised within an inclosure, may kill and sell the same from October 1 to February 1." (Laws of 1909, p. 236.)

Indiana.—The section against killing and possession of game has this clause: " Provided, that the provisions of this section shall not apply to any person or persons owning or having under his domain or control any deer, buck, doe, or fawn bred or raised in any deer park." This would permit sale of venison, but probably not its export. (Laws of 1907, ch. 219.)

Iowa.—The statutes declare it unlawful for any person other than the owner or person authorized by the owner to kill, maim, trap, or in any way injure or capture any deer, elk, or goat, except when distrained as provided by law. As Iowa has no wild deer except the few that have escaped from a private herd, the sale of venison from private preserves is not prohibited.

Kentucky.—The state law especially protects game in parks from poaching and trespass. (Stats., sec. 1250.)

Maine.—The game and fish commissioners are authorized by law to grant permits to capture moose, caribou, deer, and birds for park purposes within the State. This does not permit the sale of such game. (Rev. Stat. 1903, ch. 32, sec. 40.)

Massachusetts.—The owner may at any time kill or sell his own tame deer kept on his own grounds. (Acts of 1907, ch. 307.)

Michigan.—An act passed in 1909 makes it unlawful to capture or destroy deer kept within or that have escaped from any private inclosure. (No. 167.)

Minnesota.—Persons who desire to domesticate deer, moose, elk, or caribou may secure a permit to do so from the state board of game and fish commissioners by paying a fee of 50 cents for each animal in captivity and a like fee for each animal added later by natural increase or otherwise. The animals kept in captivity may be sold or shipped within or without the State by written permission from the commission. (Laws of 1899, ch. 161.)

Missouri.—"Nothing in this act shall be construed to prevent the shipment of deer or elk, alive or dead, from private preserves, when such elk or deer are raised in captivity." (Laws of 1909, p. 536.)

New Hampshire.—The Blue Mountain Forest Association may kill elk, deer, and moose within the confines of its game preserve until January 15 of each year and transport them outside the State at any time when accompanied by a certificate from the fish and game commission. (Pub. Stat. 1901, ch. 131, sec. 6.)

New York.—Deer may be sold during the open season, and moose, elks, caribou, and antelope from private parks may be sold during the same period. Common carriers may transport animals into the State for breeding purposes. The section forbidding transportation of venison was recently (1909) amended to provide that it "shall not apply to domesticated deer propagated in wholly inclosed deer parks, when shipments made from such parks are accompanied by a permit issued by the forest, fish, and game commission under conditions prescribed by the commissioner." (Ch. 474.)

North Carolina.—Twenty-two counties permit the owner and keeper of an inclosed game reserve, who raises deer for use or sale, to kill, sell, or use those raised or kept in said inclosure. These laws were passed in 1907 and 1909.

North Dakota.—The state game and fish board of control is authorized to issue permits to breed or domesticate any of the game birds or animals mentioned in the law. An annual report is required from persons holding such permits, and they may sell or ship game within or without the State upon receipt of written permission to do so from the board. (Laws of 1909, ch. 128.)

Oklahoma.—A section of the law passed in 1909 permits the sale of domesticated game animals and birds within the State. The law is silent on the subject of their export. (Ch. 19.)

Pennsylvania.—The state board of game commissioners may issue propagating certificates to individuals or associations that desire to raise deer or other large game animals. The land shall be inclosed by an approved wire fence not less than 8 feet high. All wild deer must first be driven from the land under the direction of a representative of the state board. A careful account of all game raised or brought to the preserve must be kept and reports of any increase made annually to the board. Deer may be killed inside the preserve and shipped only during the open season and for thirty days thereafter. They may be shipped alive for propagating purposes at any time. Each deer or carcass of deer shipped from the preserve must bear a tag furnished by the state board, by which it may be identified at any time. (Acts of 1909, No. 204.)

South Dakota.—The state game warden may issue permits to breed or domesticate deer, moose, elk, caribou, buffalo, or game birds. Annual reports are required from holders of permits. On receipt of written permission from the game warden, any of the animals held in possession in private preserves may be sold or shipped within or without the State. (Laws of 1909, ch. 240.)

Vermont.—A person may kill, sell, or dispose of deer which were obtained without the State and are owned and confined by him in a park or inclosure. (Pub. Stat. 1906, sec. 5326.)

Wisconsin.—The fish and game warden may issue permits to breed or domesticate deer, moose, elk, or caribou. A system of marking the animals in preserves established under the permits is authorized, and such animals may be sold or shipped within or without the State upon receipt of written permission to do so from the state game and fish warden. A tag identifying the animal by number must accompany every carcass or part of the carcass shipped or exposed for sale. (Laws of 1909, ch. 525.)

A few other States except from the declaration of state ownership of game that which is "under private ownership legally acquired." In the absence of specific laws permitting the sale and export of such game, there is uncertainty as to how courts would decide concerning the rights of game propagators in these States.

RESOLUTIONS BY THE AMERICAN BREEDERS' ASSOCIATION.

At the annual meeting of the American Breeders' Association held in Washington, D. C., January 28–30, 1908, the subject of breeding game and fur mammals had an important place on the programme, and at the close of the sessions, January 30, the following preamble and resolution were adopted:

> Whereas there are vast possibilities in our wild meat, fur, and game mammals, and birds, as a basis for stocking our private and public forest reserves and game preserves with a view to the conservation and fuller utilization of our natural resources and as a source of blood to be used in forming hybrids with domestic animals; therefore,
>
> *Resolved*, That the American Breeders' Association urge the attention of Congress, of state legislatures, sportsmen's societies, and private parties to the preservation of the American bison, the various members of the deer family, mountain sheep, arctic foxes, grouse, pheasants, quail, and other mammals and birds, and the carrying out of experiments to determine their wide use on lands not suited to domestic species and the determination of their value in the foundation of hybrid animals designed for production under wild and semidomesticated conditions.

At the annual meeting of the same association held at Columbia, Mo., January 6–8, 1909, the following resolution was adopted:

Resolved, That state laws regulating shooting, possession, and handling of game should be amended so as to permit the sale of live game for propagation at all times. That hand-reared game and game reared in a wild state by breeders (including farmers) should be distinguished by law so that such preserved game can be sold legally under state regulations, except during the breeding season.

SUMMARY.

The foregoing information relating to the raising of deer, elk, and other large game animals in confinement may be briefly summarized in the following conclusions:

The rearing of wild game mammals, both native and introduced, offers a promising field for experiment, as well as for the practical investment of capital.

The Rocky Mountain elk and the Virginia deer can be reared successfully and cheaply under different conditions in regard to food and climate, as has been proved by many successful experiments. The complete domestication of either species is a possibility which, if realized, would be a source of lasting benefit to the world. With proper encouragement, the production of venison from both elk and deer can be made profitable industries on lands unsuited for cattle, horses, or sheep. The rearing of both species for stocking parks and game preserves would for a time be even more profitable than the production of venison.

Instead of hampering breeders by restrictions, state laws should be modified so as to encourage the raising of deer as a source of wealth to the individual and the State. Safeguards against the destruction and sale of wild deer for domesticated deer are necessary. For this purpose a system of licensing private parks or of inspecting and tagging or otherwise marking live animals or carcasses sold or shipped is recommended.

It is believed that with proper encouragement much of the otherwise waste land in the United States may be made to yield profitable returns from the production of venison, and that this excellent and nutritious meat, instead of being denied to 99 per cent of the population of the country, may become as common and as cheap in our markets as mutton.

INDEX.

Page.
Acclimatization of the eland ... 13
  of the nilgai ... 14
Æsthetic reason for domesticating animals ... 9
Agriculture and transportation, mammals for. 10
Alces americana ... 18
  gigas ... 18
  machlis ... 18
American Breeders' Association ... 58
  resolutions, 1908 ... 58
  resolutions, 1909 ... 59
American Institute ... 30
American antelope ... 11
  protection ... 12
  range ... 11
  venison ... 12
Antelopes, exotic ... 13
  smaller ... 14
Antilocapra americana ... 11
Antlers ... 15
  of Altai wapiti ... 22
  uses ... 15
Arkansas, deer raised in captivity ... 55
Atkinson, Attorney-General, of Washington. 55
Audubon and Bachman on domestication of elk ... 28
Axis deer ... 23
Baird, S. F ... 11, 16, 18, 29
Bedford, Duke of, parks belonging to.. 13, 14, 22, 23
Binney, Henry, fence for elk ... 37
Blagden, Thomas, experience with deer ... 40, 42, 49
Blaubok, extermination ... 9
Blue Mountain Forest Association ... 57
Blue Mountain Park ... 19, 28, 57
Bonine, Isaac, experience with elk ... 32
Boots, James F., experience with mule deer.. 45
Boselaphus tragocamelus ... 13
Bradley, Herbert, killed by deer ... 48
Buckland Park, New Jersey ... 50
Buffalo, extermination ... 27
Bull, H. C., killed by elk ... 38
Canada, export of park deer ... 53
Caribou, barren-ground ... 16
  woodland ... 16
Carroll, W. J ... 17
Caton, J. D ... 12, 31, 38, 39, 45
Cephalophus ... 14
Cervulus muntjac ... 24
Cervus asiaticus ... 21
  axis ... 23, 45
  canadensis ... 19, 25
  unicolor ... 23
Chinese water deer ... 24
Chital ... 23
Colorado, private parks ... 56
Corbin preserve (Blue Mountain Park) ... 19, 28, 57
Cuppy herd of deer in Iowa ... 54
Danger of introducing foreign animals ... 24
Deer, Acapulco ... 45
  Columbia black-tailed ... 21
  crating for shipment ... 48
  exotic ... 21

Page.
Deer, fallow ... 21
  family, importance ... 14
  food ... 47
  hair ... 15
  mule ... 20
  North American ... 16
  park at Roanoke, N. C ... 41
  parks, early ... 40
    effect on game supply ... 51
  Père David ... 23
  red ... 21
  small ... 24
  Virginia ... 20, 40
  white-tailed ... 20, 40
  management ... 46
Deerhorn, uses ... 15
Deerskins ... 15
Dieterich, Charles F., experience with deer.. 53
  v. Fargo, case of ... 53
Domestication of antelope ... 12
  caribou ... 16
  elk ... 20, 29
  mammals ... 8
    æsthetic reason for ... 9
    for use in agriculture and transportation ... 10
    for food ... 10
    for fur ... 10
    selection of species ... 10
  moose ... 18
  white-tailed deer ... 20, 40
Downing, A. J., on native deer for parks ... 40
Duikers ... 14
Eland ... 13
Elaphuras davidianus ... 23
Elk ... 19, 25
  castration ... 39
  clearing out underbrush ... 35
  cost ... 37
  enmity toward wolves and dogs ... 39
  fence ... 34, 37
  flesh ... 26
  food ... 37
  gestation ... 26
  habits ... 25
  hybrids ... 28
  in Adirondacks ... 28
  in eastern United States ... 27
  in Ozark Mountains ... 33
  management ... 36
  parks ... 36
  preservation ... 26
  range ... 19
  Rocky Mountain ... 19, 25
  round-horned ... 19, 25
  venison ... 26
  vicious male ... 38
  weight ... 34
  Wyoming herds ... 25
Exotic species, introduction of ... 24
Fence for deer ... 44

Page.
Fence for elk 34, 37
Florida, law protecting private parks 56
Food of deer 46
    of elk 25
Foreign animals, objections to introduction of. 24
Fur, rearing mammals for 10
Game in Maine 26
    preserves, private 51
        state 51
    propagation 7, 52
Gazelles 13, 14
Gestation of elk 26
    muntjacs 24
    white-tailed deer 46
Gilbert, J. W., experience with elk 32
Good, Geo. S., quoted 55
Goodnight, Charles, quoted 43, 46
Grenfell, W. T., experiments with reindeer 17
Griggs, John W., experience with deer 42, 46
Harris, R. H., experience with deer 43
Hill, Joshua, experience with elk 32
Hippotragus leucophæus 9
Hornaday, W. T., quoted 18
Hybrids, deer 21, 23, 45
    elk 28
Hydrelaphus inermis 24
Illinois, deer from parks 56
Increase of deer in domestication 45
Indiana, deer from parks 56
Introduction of foreign animals 24
Iowa, protection of park deer 56
Jackson, Sheldon, introduction of reindeer 17
Japanese sika 22
Kellogg, T. D., tame elk 31
Kentucky, protection of game in parks 56
Killing deer in private parks 53
Land not utilized 40
Laws affecting game propagation 52
McKeen, W. R., experience with deer 42
Maine, permits to tame game 56
Management of elk 36
    Virginia deer 46
March, C. W., experience in shipping deer 48
Massachusetts, killing tame deer 56
Mercer, John, elk in Maryland 29
Michigan, protection of park deer 56
Minnesota, private parks 56
Missouri, tame deer 57
Moose 18
Mule deer 20, 45
Muntjacs 24
New Hampshire, Blue Mountain Park 57
New York, deer from parks 57
Nilgai 13
North Carolina, park deer 57
North Dakota, parks 57
Nowlin, D. C., quoted concerning antelope 11
Odocoileus columbianus 21
    hemionus 20
    toltecus 45
    virginianus 20, 40
    v. couesi 47
Oklahoma, deer from parks 57
Otzinachson Rod and Gun Club 50, 55
Parks, private, for deer 50
    laws relating to private 55
Peking sika 23
Pennsylvania, private parks 57

Page.
Père David deer 23
Powerscourt, Lord, experience with Japanese deer 22
    experience with Sambar deer 23
Preservation of species a reason for domestication 9
Private deer preserves 55
    ownership of deer 55
Protection of antelope 12
Pronghorn 11
Pseudaxis hortolorum 23
    nippon 22
Quagga, extinction 9
Range of American antelope 11
    elk 19
    moose 18
    mule deer 20
    white-tailed deer 20
    suitable for elk 36
Rangifer arcticus 16
    caribou 16
    tarandus 16
Reasons for domesticating mammals 9
Reindeer, Alaska 17
    Labrador 17
    Newfoundland 17
Roosevelt, Theodore, quoted 39
Roseberry, C. H., experience with deer 44
Russ, Geo. W., on raising elk 33
Sale of venison from parks 54
St. Louis Park and Agricultural Company 33, 45
Sambar, Indian 23
Sika, Japanese 22
    Peking 23
South Dakota, private parks 58
Species suitable for domestication 10
State game preserves 51
    laws relating to private ownership of deer 55
Stratton, E. L., domestication of elk 31
Stratton, Lorenzo, domestication of elk 29, 36
Taurotragus 13
Tielenius, Carl, experience with elk 28, 33
Transportation of live deer 52
    venison 52
    use of mammals 10
Trapping deer for shipment 49
Trouessart, E., domesticating mammals 8
Tuley, Joseph, elk in Virginia 29
Venison, digestibility 14
    elk 26
    from parks, sale 54
Vermont, deer from parks 58
Vicious deer 47
    elk 38
Wapiti 19
    Altai 21
    North American 19, 25
        habits 25
Weber case 54
Wetmore, M. C., experience with elk 33
Wilson, F. J., experience with elk 32
White-tailed deer 20, 40
Whitney, William C 20, 28
Wisconsin, private parks 58
Woburn Abbey, parks of Duke of Bedford 13, 14, 22, 23
Worthington, Charles C 47, 49, 50, 51

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HENRY W. HENSHAW, *Chief*

FOOD OF THE WOODPECKERS OF THE UNITED STATES

BY

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WASHINGTON
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1911

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey,
Washington, D. C., December 23, 1910.

Sir: I have the honor to transmit herewith for publication as Bulletin No. 37 of the Biological Survey, a report on the Food of the Woodpeckers of the United States, by F. E. L. Beal, assistant, Biological Survey. The diminished supply of timber and its greatly increased cost render the conservation of our remaining forests exceedingly important. It has been estimated that within the United States insects destroy trees and lumber to the value of upward of $100,000,000 annually. As boring insects are the natural enemies of trees, so birds are their natural allies. Of all birds that further the welfare of the forest, woodpeckers are the most important, many of them indeed being specially adapted to dig into wood in order to reach insect larvæ safe from all other enemies. While most woodpeckers are thus highly beneficial, the sapsuckers are injurious, since they subsist to a considerable extent on the cambium or inner bark of trees. This bulletin is meant to serve a practical end by describing the food habits of the several species, and by pointing out the extent to which each is beneficial or injurious, so that the forester, the farmer, and the orchardist may know friend from foe.

Respectfully,

H. W. Henshaw,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

Page.
Introduction........ 7
Hairy woodpecker........ 13
Downy woodpecker........ 17
Red-cockaded woodpecker........ 22
Nuttall woodpecker........ 23
Three-toed woodpeckers........ 25
Yellow-bellied woodpecker or sapsucker........ 27
Red-breasted sapsucker........ 31
Williamson sapsucker........ 32
Pileated woodpecker........ 33
Red-headed woodpecker........ 35
California woodpecker........ 43
Lewis woodpecker........ 45
Red-bellied woodpecker........ 47
Flicker........ 52
Red-shafted flicker........ 59
Ivory-billed woodpecker........ 62
Other woodpeckers........ 63

ILLUSTRATIONS.

PLATES.

		Page
PLATE	I. Hairy and downy woodpeckers	Frontispiece.
	II. Yellow-bellied sapsucker	32
	III. Red-headed woodpecker	32
	IV. California woodpecker	40
	V. Lewis woodpecker	40
	VI. Flicker	48

TEXT FIGURES.

FIG.	1. Tongues of woodpeckers	8
	2. Special development of tongues of woodpeckers	8
	3. Wood from which woodpecker has extracted insect	9

FOOD OF WOODPECKERS.

(Picidæ.)

INTRODUCTION.

During the last few decades much interest has been aroused in the preservation and extension of forest areas within the United States, and large sums of money have been spent on our National Forests. Meanwhile scientists have been studying means to combat the insect enemies of forests, which in some cases have threatened the total destruction of large tracts. There is probably no species of land plant that has not at least one insect enemy, and the trees of the forest furnish food and homes for legions. In the Fifth Report of the United States Entomological Commission over 400 species of insects are reported to feed on the oak, and the opinion is expressed that this number is far below the total. In the same work about 80 species are said to feed on the elm, 170 on the hickory, 41 on the locust, 100 on the maple, 105 on the birch, 186 on the willow, and 165 on the pine; and in each case the list is confessedly incomplete.

On this point Dr. Hopkins has said:

> The results of investigation lead to the conclusion that the annual loss from insect work on forest trees, and their crude or finished products, amounts to at least $100,000,000.
>
> No period in the life history of a tree is exempt from insect attack, and every part, from the smallest roots to the terminal buds, leaves, flowers, and fruit, may be infested by one or many species. The seed in the ground, the tender shoots of both roots and stems, and the young seedling to the matured tree, may be attacked by special enemies which injure or destroy different parts of the entire plant. In fact, living, diseased, dead, or decaying, a tree may be the home of hundreds of species and thousands of individuals of insect life.[1]
>
> Wherever the *Dendroctonus* beetles have been found in standing timber, the work of woodpeckers has been more or less common, and in some trees quite a large percentage of the beetle broods has been destroyed by the birds. The evidence gathered in Maine a few years ago indicates quite conclusively that the birds were rendering a most valuable service as a natural check to the multiplication and destructive work of the eastern spruce beetle. The work of birds is common in sections where species 1 [*Dendroctonus brevicomis*], 9 [*D. monticolæ*], and 10 [*D. ponderosæ*], and other western species are prevalent. Yet birds evidently render the greatest service where but few trees are being killed, since their concentrated work may prevent an abnormal increase of the beetles; but where many hundreds or thousands of trees are being killed, the limited number of birds can have little or no effect. Therefore, while the birds are among the foresters' valuable friends, they can not, even with the utmost protection, always be relied upon to protect the forest from its enemies.[2]

---

[1] From manuscript of lecture on Forest Insects and Their Destructive Work, by Dr. A. D. Hopkins, in charge of Forest Insect Investigations, Bureau of Entomology, U. S. Dept. Agric.

[2] Hopkins, A. D., Bull. 83, Bureau of Entomology, U. S. Dept. Agric., Part I, pp. 27-28, 1909.

From these considerations it is at once apparent how important must be any agency that restrains or limits this great army of tree destroyers. Of all birds that further the welfare of trees, whether of forest or orchard, woodpeckers are the most important. The value of their work in dollars and cents is impossible to calculate, but careful study of their food in both field and laboratory has brought out many facts of practical importance.

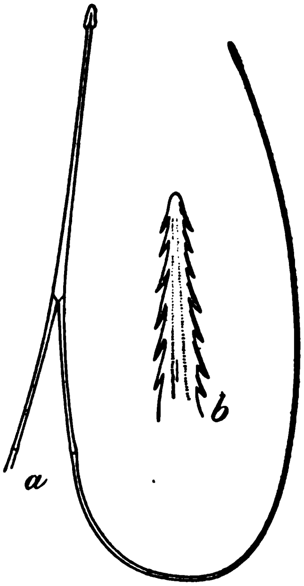

FIG. 1.—Tongues of woodpeckers.

Woodpeckers are essentially arboreal in their habits and obtain the greater part of their food from trees. Their physical conformation eminently adapts them to this mode of life. Their legs are rather short and stout, and the toes are furnished with strong, sharp claws. With the exception of the genus *Picoides*, all North American woodpeckers have four toes, two of which point forward and two backward. To further aid in maintaining themselves on the trunks of trees, their tails are composed of stiff feathers terminating in sharp spines, which can be pressed against the bark and so serve as a prop to hold the bird in an upright position while it is at work. Woodpeckers are thus enabled to cling easily to the trunks and branches and to strike effective blows with their beaks upon the bark or wood

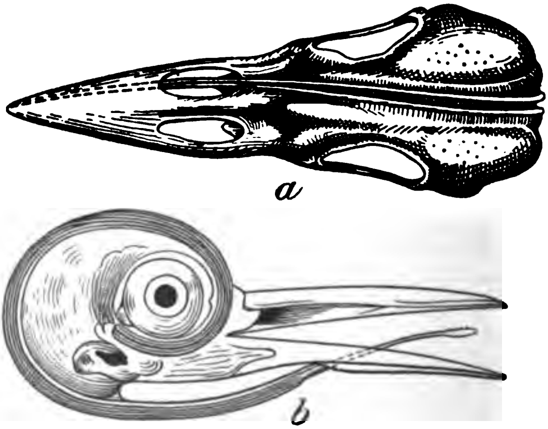

FIG. 2.—Special development of tongues of woodpeckers.

As much of the food of woodpeckers is obtained from solid wood, Nature has provided most of them with a stout beak having a chisel-shaped point, which forms an exceedingly effective wood-cutting instrument. But the most peculiar and interesting point in the anatomy of these birds is the tongue. This is more or less cylindrical in form and usually very long (fig. 1, *a*). At the anterior end it generally terminates in a hard point, with more or less barbs upon the sides (fig. 1, *b*). Posteriorly the typical woodpecker tongue is extended in two long, slender filaments of the hyoid bone which curl up around the back of the skull and, while they commonly stop between the eyes, in some species they pass around the eye (fig. 2, *b*), but in others enter the right nasal opening and extend to the end of the beak (fig. 2, *a*). In this last case the tongue is practically twice the length of the head. Posteriorly this organ is inclosed in a muscular sheath by means of which it can be extruded from the mouth to a considerable length, and used as a most effective instrument for dislodging grubs or ants from their burrows in wood or bark. Hence, while most birds have to be content with such insects as they find on the surface or in open crevices, the woodpeckers devote their energies to those larvæ or grubs which are beneath the bark or even in the heart of the tree. They locate their hidden prey with great accuracy and often cut small holes directly to the burrows of the grubs. In figure 3 the grub had eaten a burrow through the heart of a maple sapling, but its position was accurately determined by the bird, which then cut through the solid live wood until it reached the burrow and extracted the insect.

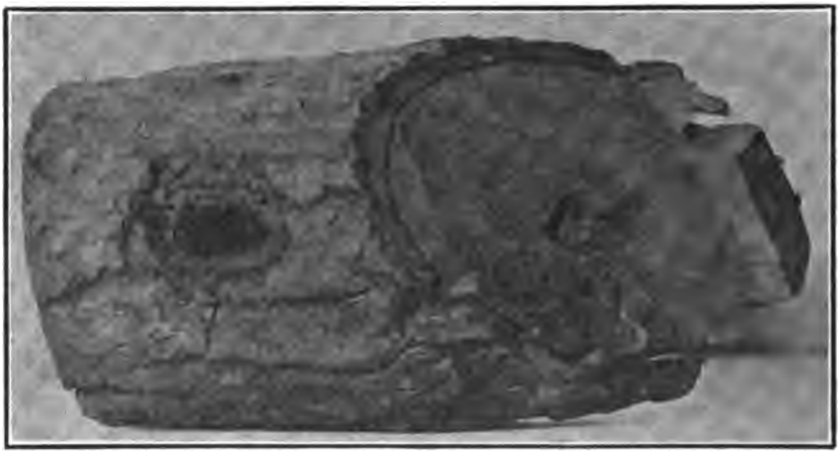

FIG. 3.—Wood from which woodpecker has extracted insect.

In the United States, exclusive of outlying possessions, there are about 45 species and subspecies of this family, most of which are of decided economic importance. As a family they are much less migratory than most other birds, and a majority of the species occupy the same range throughout the year, which adds materially to their value to farmers. Their food consists so largely of wood-boring grubs, hibernating insects, and insects' eggs and pupæ that their supplies do not fail even in the coldest weather.

The present paper is based upon the examination of 3,453 stomachs of woodpeckers representing 16 species and nearly twice as many subspecies, taken in all parts of the United States, with a few from Canada. In the following table the species are arranged in the order of the average amount of animal food contained in their stomachs.

Name of species.	Number of stomachs.	Per cent of animal food.	Per cent of vegetable food.
Three-toed woodpecker (*Picoides americanus*)	23	94.06	5.94
Arctic three-toed woodpecker (*Picoides arcticus*)	28	88.69	11.31
Williamson sapsucker (*Sphyrapicus thyroideus*)	17	86.67	13.33
Red-cockaded woodpecker (*Dryobates borealis*)	76	81.06	18.94
Nuttall woodpecker (*Dryobates nuttalli*)	53	79.41	20.59
Hairy woodpecker (*Dryobates villosus*)	382	77.67	22.33
Downy woodpecker (*Dryobates pubescens*)	723	76.05	23.95
Pileated woodpecker (*Phlœotomus pileatus*)	80	72.88	27.12
Red-breasted sapsucker (*Sphyrapicus ruber*)	34	68.92	31.08
Red-shafted flicker (*Colaptes cafer*)	183	67.74	32.26
Flicker (*Colaptes auratus*)	684	60.92	39.08
Yellow-bellied sapsucker (*Sphyrapicus varius*)	313	49.31	50.69
Lewis woodpecker (*Asyndesmus lewisi*)	59	37.48	62.52
Red-headed woodpecker (*Melanerpes erythrocephalus*)	443	33.83	66.17
Red-bellied woodpecker (*Centurus carolinus*)	271	30.94	69.06
California woodpecker (*Melanerpes f. bairdi*)	84	22.59	77.41
Total	3,453		
Average		64.26	35.74

It is not probable that these relations are absolute in every case. The position of *Sphyrapicus ruber* above the two species of *Colaptes* is perhaps accidental, and the examination of a few stomachs more or less would be likely to change slightly the relative positions. The vegetable food, of course, stands in an inverse ratio to the animal. Mineral matter (sand) is not taken largely by woodpeckers. The most is found in the stomachs of the flickers, but it is probably picked up accidentally with ants, of which these birds eat great numbers. Ants constitute the largest item of animal food—28.41 per cent, considering the whole 16 species collectively—and are actually the largest item in the stomachs of 8 species. The Williamson sapsucker, the red-cockaded woodpecker, and the two flickers take the highest rank in this respect. Beetles stand next in importance, and amount to 20.42 per cent. These two items together form nearly half the food. The remainder of the animal food is composed of insects, with a few spiders, millepeds, and sowbugs, and occasionally a salamander, tree frog, lizard, or snail. In the following table is given the average percentage of ants and beetles in the stomach. The species are arranged in the order of their rank as ant eaters.

Name of species.	Per cent of ants.	Per cent of beetles.
Williamson sapsucker (*Sphyrapicus thyroideus*)	85.94	0.13
Red-cockaded woodpecker (*Dryobates borealis*)	56.75	11.02
Red-shafted flicker (*Colaptes cafer*)	53.82	6.55
Flicker (*Colaptes auratus*)	49.75	5.14
Red-breasted sapsucker (*Sphyrapicus ruber*)	42.49	4.02
Pileated woodpecker (*Phlœotomus pileatus*)	39.91	22.01
Yellow-bellied sapsucker (*Sphyrapicus varius*)	34.31	6.02
Downy woodpecker (*Dryobates pubescens*)	21.36	21.55
Hairy woodpecker (*Dryobates villosus*)	17.10	41.42
Lewis woodpecker (*Asyndesmus lewisi*)	11.87	9.12
Three-toed woodpecker (*Picoides americanus*)	8.29	71.05
Nuttall woodpecker (*Dryobates nuttalli*)	8.19	28.86
California woodpecker (*Melanerpes f. bairdi*)	8.00	2.67
Red-bellied woodpecker (*Centurus carolinus*)	6.45	10.18
Arctic three-toed woodpecker (*Picoides arcticus*)	6.35	67.66
Red-headed woodpecker (*Melanerpes erythrocephalus*)	5.17	18.85
Average	28.49	20.39

If the 16 species of woodpeckers herein discussed were arranged in the order of their usefulness according to their food, they would stand about as at top of page 10, except that the 3 species of Sphyrapicus, owing to their sap-sucking propensities, might be placed at the foot of the column. It is unfortunate that so few stomachs of the three or four species nearest the top have been received, but probably those examined were in no way exceptional. The 2 species of *Picoides* are among the most useful birds, especially in the forest, of which they are preeminently the conservators. More than 60 per cent of the animal food of these two birds consists of the larvæ of wood-boring beetles, which they dig from the bark and wood of trees. The two species *Dryobates pubescens* and *D. villosus* do not fall far behind in this good work, and several others eat very appreciable quantities of wood borers. Among the beetles eaten by the different birds are naturally some useful species, such as the predaceous ground beetles (Carabidæ) or tiger beetles (Cicindelidæ). The redhead eats useful beetles to the extent of 7.34 per cent of its diet, the Lewis woodpecker, with 6.7 per cent, stands next on the list of offenders in this respect, followed by the red-shafted flicker with 3.9 per cent, and the eastern flicker with less than 2 per cent. No other species had eaten so much as 1 per cent of these beetles. Whatever sins woodpeckers may commit, the destruction of useful beetles is not one of them.

Nearly all the vegetable food, except a few seeds, including some grain, can be included under three items—fruit, cambium, and mast. The greatest interest attaches to the cambium, which is a jellylike substance found just under the bark of growing trees and from which both wood and bark are formed. The smaller species of woodpeckers have been accused of pecking the bark from fruit and forest trees to an injurious extent in order to get this substance. While nearly all members of the family eat some cambium, the only ones that really do much harm by the habit appear to be the yellow-bellied sapsucker (*Sphyrapicus varius*) and others of the same genus. With the yellow-bellied sapsucker cambium amounts to about 17 per cent of the annual food and in April reaches 48 per cent. As the substance is often semifluid, probably much passes almost immediately out of the stomach, leaving only the harder and less easily digested part, so that a much larger amount is eaten than is shown by stomach examination.

In obtaining the cambium the bird sometimes denudes the tree of its bark over a considerable area, and so ruins it for any economic use except fuel; at other times a series of single punctures are made in lines extending around the tree, and as new layers of wood grow over these, the indentation at each puncture becomes less and less pronounced. If, after some years, this timber be cut and sawed, a tangential or circular cut across the punctures gives a bird's-eye appearance very similar to that which Nature produces in some maples. A radial cut through the punctures gives the curly look often found in many woods. It frequently happens, however, that water enters at the punctures and causes a slight decay, which usually disfigures the wood by making a dark stain, though occasionally the effect is ornamental.

With the possible exception of the crow, no birds have been subject to so much adverse criticism as the woodpeckers. When they are seen scrambling over fruit trees and fresh holes are found in the bark, it is concluded that they must be doing harm. But woodpeckers, except a few species, rarely disfigure a healthy tree, but when they find a tree infested by wood-boring larvæ, they locate the insects accurately, draw them out, and devour them. If in succeeding years the burrows formerly occupied by the larvæ are used by a colony of ants, they in turn are dug out and destroyed.

The following are samples of testimony by Dr. Hopkins and other eminent entomologists to the persistent and effective work of woodpeckers in destroying wood-boring beetles and other insect enemies of trees:

> As has already been stated, woodpeckers are the most important enemies of the bark beetle, and appear to be of inestimable value to the spruce-timber interests of the Northeast. Indeed, I feel confident that in the many hundreds of infested trees examined at least one-half of the beetles and their young had been destroyed by the birds, and in many cases it was evident that even a greater proportion had perished from this cause alone.
>
> Estimating 100 beetles to the square foot of bark in the average infested tree, and an average of 60 square feet of infested bark, it is possible for each tree to yield an average of 6,000 individuals; 100 trees, 600,000, and so on. It is therefore plain that, if one-half or two-thirds of this number are destroyed by the birds and other enemies, the amount of timber the remainder can kill will be lessened. This is all the more apparent when it is remembered that it is only when the beetles occur in great numbers that they can overcome the resistance of the living trees.[1]
>
> Birds contribute their share, also, in destroying larvæ and pupæ. The work of woodpeckers was found upon most of the trees which had been killed by *Dendroctonus brevicomis*, and these birds had evidently destroyed a large percentage of the insects in some of the trees.[2]
>
> As natural enemies of this insect [the maple borer, *Plagionotus speciosus*] it is probable that various species of woodpeckers render the greatest service. At Huntington, Mass., I have seen the hairy woodpecker, the downy woodpecker, and the flicker feeding upon white larvæ taken from beneath the bark of maples infested by this borer.[3]
>
> Woodpeckers do much good by hammering holes in the bark of infested cottonwoods and devouring the young carpenter worms [larvæ of *Cossus populi*]. We certainly ought to protect these feathered friends of ours instead of allowing every small boy in the country to shoot them whenever he pleases.[4]

---

[1] Hopkins, A. D., Bull. 28 (new ser.), Division of Entomology, U. S. Dept. Agric., pp. 23, 25-26, 1901.

[2] Webb, J. L., Bull. 58, Part II, Bureau of Entomology, U. S. Dept. Agric., p. 27, 1906.

[3] Kirkland, A. H., in Mass. Crop Report for June, 1897, p. 32, 1897.

[4] Doten, S. B., Bull. 49, Nevada Agric. Exper. Sta., p. 12, 1900.

I have found no parasite of this larva [*Hepialus argenteomaculatus*], but I have seen that the woodpeckers are its deadly foes. In April, 1886, I had a favorable opportunity to search for the borer and was astonished at the scores removed by these birds. They often drill through a deep layer of wood; often two holes are made one above the other, the purpose being obvious. The morsel is evidently located, or its burrow rather, by sounding, as I noticed many instances in which a row of punctures surrounded the base of the alder. The destroyers are sometimes mistaken, for I found their drillings, evidently made in search of this larva, in sound wood in which there were no borers, but these were few compared with the successful trials.

Is it the activity of these birds that prevents the abundance in the forests of certain borers, e. g. *Aegeria acerni*, whilst the same insect is often destructively abundant in the ornamental maples of cities and villages? [1]

HAIRY WOODPECKER.

(*Dryobates villosus* subspp.)

The hairy woodpecker (frontispiece), in one or another of its various forms, inhabits the whole of temperate North America, but is rare over some extensive areas. It is a rather restless, noisy bird, as compared with its smaller relative, the downy, and makes itself conspicuous by loud calls and rapid flights from tree to tree. It is eminently arboreal in its habits and gets most of its food from trees. While sometimes found in the midst of a dense forest, it prefers the outer edge of the woodland or groves or orchards. In the latter it is quite at home, especially if the trees be old and neglected, for then they usually offer decayed knots and limbs where wood borers establish their colonies. The bird is not migratory, unless within very narrow limits, and where it occurs at all can usually be found the year round. It nests in a cavity which it excavates in a partly decayed trunk or branch. While often seen in the orchard, the hairy does not go there for fruit. More than three-fourths of its food consists of animal matter, and less than a fourth of the remainder is fruit, mostly of wild species.

In the investigation of the food of the hairy woodpecker detailed below, 382 stomachs were examined. They were obtained from 33 States and Territories, the District of Columbia, and Canada, and were taken in every month of the year. They undoubtedly embrace all the recognized subspecies, but as some of them were collected before all the forms had been defined, they can not now be distinguished. However, as the food of the various subspecies does not differ materially, the species has been treated as a whole. In the first analysis the food divides into 77.67 per cent of animal matter and 22.33 of vegetable. The animal food consists of insects, with a few spiders and millepeds; the vegetable part is made up of fruit, seeds, and a number of miscellaneous substances. This ratio of animal to vegetable does not vary greatly during the year, the greatest difference occurring in June, when the stomachs show 90 per cent of animal to 10 per cent of vegetable food. There is, however, no regular increase or decrease as the seasons change, such as is noted in birds that subsist upon flying insects and summer fruits. The wood-boring larvæ upon which this bird so largely feeds can be obtained at all times of the year, and the same is true of most of the vegetable food.

---

[1] Kellicott, D. S., Insect Life, I, 251, Feb., 1889.

Animal food.—The largest item in the annual diet of the hairy woodpecker consists of the larvæ of cerambycid and buprestid beetles, with a few lucanids and perhaps some other wood borers. These insects constitute over 31 per cent of the food and are eaten in every month of the year. The greatest amount is taken in December, when it reaches 41 per cent of the whole; and in May, the month of least consumption, it still amounts to over 21 per cent. This shows how earnest these birds are in their efforts to procure this kind of food. In summer, insects and small fruits abound—enough to satisfy appetite and in variety apparently suited to every taste—but the birds still search for and obtain these wood-boring grubs to the extent of a fifth or more of their daily food, at the cost of hours of hard labor in digging them from the tree. One stomach contained 100 of these larvæ and 83 and 50, respectively, were taken from two others. Of the 382 stomachs, 204, or 53 per cent, contained these grubs, and 27 of them held no other food. Other beetles amount to a little more than 9 per cent. They are distributed among a number of families, but are nearly all more or less harmful.

Weevils (Rhynchophora), or snout beetles, aggregate a little more than 3 per cent, and are mostly represented by the curculios (Curculionidæ) and engraver beetles (Scolytidæ).. One of the former, *Dorytomus mucidus*, seems to be a favorite, as it was found in a number of stomachs, of which one contained 109 and another 63 individuals. The engravers were found in 18 stomachs. One contained 50 adults and 25 larvæ; another, 21 adults and 10 larvæ. They were of such species as *Tomicus cælatus* and *Polygraphus rufipennis*. Of the latter, 17 individuals were taken from one stomach. A few carabids, or predaceous ground beetles, were also found. The average amount of these useful insects consumed is sixty one-hundredths of 1 per cent (0.60). The month of greatest consumption is March, when they are eaten to the extent of 2.46 per cent of the whole food. Evidently this bird does little harm by eating useful beetles.

Ants stand second in importance in the diet of the hairy woodpecker. They amount to a little more than 17 per cent, and are eaten in every month. In January, which is the month of greatest consumption, they reach more than 27 per cent and nearly the same in February. They are apparently eaten the least in November, when they aggregate somewhat more than 10 per cent, but this may be accidental, as both October and December show higher percentages and July practically the same. In a general way these insects are eaten most in winter and early spring, but every month has a good percentage. Hymenoptera other than ants are taken very irregularly and in small quantities. In September somewhat more than 5 per cent were eaten, but stomachs taken in May and December contained none at all, and the average for the year is but a little more than 1 per cent. In one stomach were found sawfly larvæ, insects which do not appear to be eaten extensively by birds.

Caterpillars are the next most important item of the hairy's food. They amount to a little less than 10 per cent, and were found in every month. The greater number were taken in August, when they aggregated nearly 19 per cent, while March showed the least, a little less than 2 per cent. Many of them were wood-boring species dug out from the wood, like the beetle larvæ. Prof. F. M. Webster states that he has seen a hairy woodpecker successfully peck a hole through the parchment-like covering of the cocoon of a Cecropia moth and devour the contents. On examining more than 20 cocoons in a grove of box elders, he found only 2 uninjured.

Bugs (Hemiptera) are evidently not a favorite food, as they were found only to the extent of 2.41 per cent for the year. June appears to be the month of greatest consumption, with somewhat less than 8 per cent, but four months show none at all, and bugs are very irregularly distributed through the rest of the year. Plant-lice (aphids) were found in 2 stomachs and scales in 4. One of the latter was identified as the cherry or plum scale (*Eulecanium cerasifex*). Orthoptera, that is, grasshoppers, crickets, and cockroaches, are rarely eaten by the hairy. A few eggs, probably those of tree crickets, and the egg cases (oötheca) of cockroaches, constitute the bulk of this food. These with a few miscellaneous insects amount to a little more than 2 per cent for the year. Spiders with their cocoons of eggs, including one jointed spider (Solpugidæ), and a few millepeds, were eaten to the extent of about 3.5 per cent, which completes the quota of animal food.

The following is a list of insects identified in the food of the hairy woodpecker:

COLEOPTERA.

Agonoderus pallipes.
Ips fasciatus.
Melanotus cribricollis.
Chrysobothris sp.
Cymatodera undulata.
Lachnosterna sp
Ergates sp.
Asemum mœstum.
Eleodes sp.
Nyctobates pennsylvanica.
Upis ceramboides.
Boletotherus bifurcus.
Boletophagus corticola.
Dendroides sp.
Dorytomus mucidus.
Tomicus cœlatus.
Polygraphus rufipennis.

HYMENOPTERA.

Ant (*Camponotus pictus*).

DIPTERA.

Bluebottle fly (*Phormia* sp.).

HEMIPTERA.

Plum and cherry scale (*Eulecanium cerasifex*).

Harvest fly (*Tibicen rimosa*).

Vegetable food.—The vegetable food of the hairy woodpecker may be considered under four heads: Fruit, grain, seeds, and miscellaneous vegetable substances. Fruit amounts to 5.22 per cent of the food, and was contained in 54 stomachs, of which 13 held what was diagnosed as domestic varieties, and 41 contained wild species. Rubus seeds (blackberries or raspberries) were identified in 4 stomachs, and were counted as domestic fruit, but it is perhaps more probable that they were wild. Strawberry seeds (occurring in 1 stomach) and pulp (thought to be apple) were the only other cultivated varieties that could be distinguished with a reasonable degree of certainty. Evidently the hairy woodpecker does no damage by preying upon orchard or garden products. Of wild fruit 18 species were identified. It constitutes the great bulk of the fruit eaten, and is nearly all of varieties not useful to man.

Corn was the only grain discovered in the food. It was found in 10 stomachs, and amounted to 1.37 per cent. In 2 stomachs taken in August and September it was still in the milk, but all the rest was eaten in winter, so it must have been waste. Seeds of various plants had been eaten by 18 birds, but most of them were of little economic value. The seed of poison ivy and poison sumac (*Rhus radicans* and *R. vernix*) were found in 17 stomachs, and as they usually pass through the alimentary canal uninjured, the birds do some harm by scattering the seeds of these noxious plants. The total percentage of seeds of all kinds is 4.50.

Cambium, or the inner bark of trees, was identified in 23 stomachs. Evidently the hairy does but little damage by denuding trees of their bark. Mast, made up of acorns, hazelnuts, and beechnuts, was found in 50 stomachs. It was mostly taken in the fall and winter months, and appears to be quite a favorite food during the cooler part of the year. Dr. Merriam says that in northern New York the hairy woodpecker, like the other woodpeckers of the Adirondack region, feeds largely on beechnuts. In late fall, winter, and early spring following good yields of beechnuts, the nuts form the principal food of the woodpeckers. When grubs and ants are taken from decayed or decaying trees, bits of rotten wood, dead leaves, and other rubbish are eaten with them. Such material was found in 72 stomachs, though in most cases the percentage was small. Cambium, mast, and rubbish together constitute a little less than 11 per cent of the food.

The following is the list of fruits and seeds identified in the food:

Foxtail grass (*Ixophorus* sp.).
Bayberry seed (*Myrica carolinensis*).
Hazelnut (*Corylus* sp.).
Beechnut (*Fagus americanus*).
Acorn (*Quercus* sp.).
Mulberry (*Morus rubra*).
Sassafras berry (*Sassafras sassafras*).
Spice berry (*Benzoin benzoin*).
Pigweed (*Amaranthus* sp.).
Pokeberry (*Phytolacca decandra*).
Vervain (*Verbena* sp.).
Blueberry (*Vaccinium* sp.).
Elderberry (*Sambucus canadensis*).
Sour gum (*Nyssa sylvatica*).
Flowering dogwood (*Cornus florida*).
Rough-leaved dogwood (*Cornus asperifolia*).
Juneberry (*Amelanchier canadensis*).
Northwestern Juneberry (*Amelanchier alnifolia*).
Chokeberry (*Aronia* sp.).
Strawberry (*Fragaria* sp.).
Chokecherry (*Prunus virginiana*).
Black or rum cherry (*Prunus serotina*).
Woodbine berry (*Parthenocissus quinquefolia*).
Frost grape (*Vitis cordifolia*).
Sumac (*Rhus glabra*).
Poison sumac (*Rhus vernix*).
Poison ivy (*Rhus radicans*).
Black mustard (*Brassica nigra*).
Barberry (*Berberis* sp.).
Magnolia (*Magnolia fœtida*).

Summary.—The foregoing analysis of the food of the hairy woodpecker shows that it is a bird from which the orchardist and forester have nothing to fear and much to gain. The quantity of useful insects or economic produce which it eats is insignificant. On the other hand, the number of destructive larvæ which it devours must have a very sensible effect in reducing the abundance of these pests.

DOWNY WOODPECKER.

(*Dryobates pubescens* subspp.)

The downy woodpecker (frontispiece) is the smallest member of the family in the United States. With its various forms it occupies practically the whole country and extends north into British America and as far as Alaska. To the ordinary observer it is but a miniature edition of the hairy, as the plumage is practically the same. It is also a quieter bird and probably the least wary and suspicious member of the family. When busy in search of food, it pays little attention to human intruders, and often the first intimation of its presence is a gentle tapping on a dead branch or knot only a few yards away, where a colony of ants or some wood-boring larvæ have established themselves.

Like the hairy, it does not migrate, and may be found on its range at any time during the year. Owing, perhaps, to the absence of so many other birds and the leafless condition of the trees, it seems to be most conspicuous in winter. After the summer visitors have gone southward, the downy has a habit of associating with a mixed company of titmice, creepers, nuthatches, and sometimes a few kinglets, who seem to be bound together by a community of interest in the matter of food, for they all forage over the bark of the trunks and branches of trees and eat practically the same things.

The following are samples of testimony as to the good work of the downy:

> The downy woodpecker, which is so common in Montana and which is so often seen in our orchards, is the fruit-grower's friend. Besides picking up miscellaneous pests it locates burrows of this borer [flat-headed apple-tree borer, *Chrysobothris femorata*] and extracts them in considerable numbers. In the older orchards of Montana scarcely a tree can be found that does not bear the marks of woodpeckers, a large proportion of which are made by this species.[1]

Mr. E. Dwight Sanderson, in speaking of the work of the downy woodpecker, says:

> He is the arch enemy of the codling moth and were it not for his good offices in destroying the larvæ in the winter your apple crop might frequently be a failure.[2]

Prof. Samuel Aughey examined four stomachs of the downy woodpecker in Nebraska, all of which contained grasshoppers.

The late Dr. Townend Glover, entomologist of the Department of Agriculture, states that the stomach of a downy woodpecker shot in February "was filled with black ants." He states further:

> On one occasion a downy woodpecker was observed by myself making a number of small, rough-edged perforations in the bark of a young ash tree, and upon examining the tree when the bird had flown it was found that wherever the bark had been injured the young larvæ of a wood-eating beetle had been snugly coiled underneath, and had been destroyed by the bird.[3]

In the laboratory investigation of the food of the downy woodpecker 723 stomachs were examined. They were collected in 33 States, the District of Columbia, and Canada. They are quite regularly distributed over the 12 months of the year, and probably represent fairly the average annual food. This is made up of 76.05 per cent of animal matter to 23.95 per cent of vegetable.

Animal food.—Beetles taken collectively amount to 21.55 per cent, and are the largest item of the food. Of these, a little less than 14 per cent are wood-boring larvæ, principally cerambycids, with some buprestids. They were found in 289 stomachs, or about 40 per cent of all, and 10 contained no other food. This is only about half the amount found in the stomachs of the hairy woodpecker, and shows that the downy pecks wood much less than the hairy. These larvæ are eaten at all times of the year, though the most are taken in the cooler months. In November they constitute 20 per cent of the food, which is the maximum, though in the other fall months and in the winter and spring months they do not fall far below. In June the minimum of 4.5 per cent was eaten. The economic value of the destruction of these larvæ is very great.

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[1] Cooley, R. A., Bull. 51, Montana Agric. Exper. Sta., p. 226, 1903.

[2] Bull. 131, New Hampshire Agric. Exper. Sta., p. 18, 1907.

[3] U. S. Commissioner of Agric., Rept. for 1865, pp. 37–38, 1866.

Weevils amount to a little more than 3 per cent, but appear to be a rather favorite food, as they were found in 107 stomachs, and 4 contained 50, 36, 34, and 33 adult individuals, respectively, while in another were 100 in the pupal stage. The engravers (Scolytidæ) were identified in 12 stomachs. Other beetles aggregate a little less than 5 per cent of the food, and are all more or less harmful except a few carabids, which amount to 0.80 per cent for the year.

Ants are eaten by the downy to the extent of 21.36 per cent of its diet, and are taken more regularly than any other element of the food. October, with 9.85 per cent, appears to be the month of minimum consumption, but it is doubtful if this would always hold, as every other month shows at least twice this amount. Hymenoptera other than ants are eaten very sparingly by the downy. They aggregate only 1.18 per cent, and in June, the month of greatest consumption, amount to only 2.45 per cent, while none were found in the 28 stomachs taken in May.

Hemiptera, or bugs, were found in 111 stomachs, and constitute 8.57 per cent of the food. Scales, or bark lice, were found in 41 stomachs and aphids, or plant lice, in 20. A collection of 10 stomachs taken in Maine in March contained from 90 to 100 per cent of scales, the average for 10 stomachs being 93.10 per cent. This would seem to indicate that where these insects abound, the birds collect and feed upon them almost exclusively. Scales and plant lice together amount to 2.85 per cent of the yearly food. Four genera and two species of scales were identified. Bugs of various other species reach a little less than 6 per cent.

Caterpillars appear to be a very acceptable food for the downy woodpecker, as they constitute 16.50 per cent of the yearly diet. A large proportion of them are of the wood-boring species, and were evidently dug out of the wood, the same as the beetle larvæ. Others are surface feeders taken from leaves and bark. In this connection the greatest interest attaches to the pupæ and larvæ of the codling moth, generally recognized as the worst pest of the apple orchard. These insects, in one stage or the other, were identified in 8 stomachs. While this is a small number, the wonder is that the bird gets them at all. The eggs are minute, and as soon as they hatch the larvæ bore into the fruit, where they feed in security, though it is claimed by some observers that woodpeckers sometimes dig them out. When full grown, they leave the apple and crawl into some cranny, where they change to pupæ. It is in this condition, i. e., as larvæ full grown or pupæ, that they are secured by the birds. One stomach of the downy contained 18, and another 16 of these grubs. As the adult moth flies by night and lies hidden during the day, it is probably not often taken by birds. In any case, it would be hard to identify in the stomachs. Various insects, including grasshoppers and flies, make up about 2 per cent of the food. Grasshoppers, though so acceptable to many birds, were found in only 2 stomachs of the downy. On the other hand, eggs of grasshoppers, crickets, katydids, and cockroaches were identified in 48 stomachs, mostly taken in the fall and winter. Eleven stomachs from Kansas collected in December deserve special notice. Eight of them contained the eggs of grasshoppers to an average extent of 10 per cent of all the contents. Seven stomachs taken in Illinois in March contained grasshoppers' eggs to an average of over 46 per cent of the whole food. This is evidence of valuable service and emphasizes the fact that this bird resorts to the ground for food in case of necessity.

Miscellaneous insects amount to but 2.80 per cent, but among them is one that deserves particular notice. This is the immature form of the dobson (*Corydalis cornutas*), a large aquatic insect of nocturnal habits, seldom seen except when it approaches a bright light. The larvæ are commonly known as hellgramites, and are usually found under stones in the beds of streams, though sometimes seen among wet rubbish near water. How a woodpecker could obtain these creatures is a mystery, but 1 stomach of the downy contained the remains of at least 4 of the larvæ, and in another was 1 in the pupal stage.

Spiders, millepeds, pseudoscorpions, sowbugs, and a few snails aggregate 4.09 per cent, and complete the quota of the animal food.

The following is a list of insects identified in the food:

COLEOPTERA.

Amara sp.
Gynandropus hylacis.
Stenolophus sp.
Ips fasciatus.
Tenebrioides bimaculata.
Dolopius lateralis.
Melanotus sp.
Chrysobothris sp.
Catorama sp.
Aphodius inquinatus.
Elaphidion sp.
Rhagium lineatum.
Oberea sp.
Diachus auratus.
Gastroidea cyanea.
Melasoma californica.
Platydema sp.
Helops æreus.
Notoxus alamedæ.
Pandeletejus hilaris.
Dorytomus mucidus.
Dorytomus brevicollis.
Desmoris constrictus.
Gymnetron teter.
Conotrachelus naso.
Cryptorhynchus ferratus.
Centrinus sp.
Balaninus sp.
Xyloterus bivittatus.
Hylesinus aculeatus.
Piezocorynus mixtus.

HYMENOPTERA.

Ants (*Camponotus marginatus* and *C. pennsylvanicus*).

LEPIDOPTERA.

Tent caterpillar (*Malacosoma* sp.).
Cotton bollworm (*Heliothis obsoletus*).
Codling moth (*Carpocapsa pomonella*).

HEMIPTERA.

False chinch bug (*Piesma cinerea*).
Red bug (*Largus succinctus*).
White scale (*Aspidiotus* sp.).
Oak scale (*Kermes* sp.).
Olive scale (*Saissetia oleæ*).
Plum and cherry scale (*Eulecanium cerasifex*).

ORTHOPTERA.

Large meadow grasshopper (*Orchelimum glaberrimum*).

NEUROPTERA.

Dobson (*Corydalis cornuta*).

Vegetable food.—Fruit was eaten to the extent of 5.85 per cent of the whole food. Most of it is of useless wild varieties. Ten species were identified by their seeds, of which the Rubus fruits, i. e., raspberries or blackberries, might have been cultivated, but probably were not. They were found in only 1 stomach. A number of stomachs contained fruit pulp, which could not be further identified and may have been cultivated. Corn was found in 20 stomachs, most of it taken in the winter and early spring months, so that it was waste grain, except that found in 2 stomachs in August and September, which was probably in the milk. A few other stomachs held what was thought to be grain of some kind, but was too finely ground for further identification. Grain of all kinds aggregates 1.66 per cent.

The poison Rhuses (*Rhus radicans*, *R. vernix*, *R. diversiloba*, and *R. toxicodendron*) seem to afford a favorite winter food for many birds. While the seeds themselves are so thoroughly protected by a hard, horny coating that they are seldom broken in the stomachs, they are overlaid by a white waxy pulp, which easily comes off, and is probably very nutritious. These seeds were found in 86 stomachs of the downy woodpecker, and they amount to 5.93 per cent of the food. Unfortunately they germinate freely after they have been voided, and probably these birds are the most efficient agents in distributing these noxious plants. Mast, i. e., acorns, beechnuts, chestnuts, hazelnuts, chinquapins, with a few other smaller seeds, amounts to 8.20 per cent of the food. This food is eaten in every month—the most in January and the least in July. A little cambium and some rubbish make up the remainder of the vegetable food, 2.31 per cent. The charge sometimes made that the downy injures trees by eating the inner bark is disproved. It eats cambium rarely and in small quantities.

The following seeds and fruits were found in the downy's food:

Bayberry (*Myrica carolinensis*).
Hornbeam (*Ostrya virginiana*).
Beech (*Fagus americanus*).
Oak (*Quercus* sp.).
Sorrel (*Rumex* sp.).
Smartweed (*Polygonum* sp.).
Pokeweed (*Phytolacca decandra*).
Blackberry or raspberry (*Rubus* sp.).

Mountain ash (*Sorbus americana*).
Juneberry (*Amelanchier canadensis*).
Poison ivy (*Rhus radicans*).
Poison oak (*Rhus diversiloba*).
Woodbine (*Parthenocissus quinquefolia*).
Flowering dogwood (*Cornus florida*).
Rough-leaved dogwood (*Cornus asperifolia*).
Alternate-leaved dogwood (*Cornus alternifolia*).
Mullein (*Verbascum thapsus*).
Elderberry (*Sambucus canadensis*).
Sunflower (*Helianthus* sp.).
Blueberry (*Vaccinium* sp.).

Summary.—The foregoing discussion of the food of the downy woodpecker shows it to be one of our most useful species. The only complaint against the bird is on the score of disseminating the poisonous species of Rhus. However, it is fortunate that the bird can live on this food when it is difficult to procure anything else. The insect food selected by the downy is almost all of species economically harmful.

RED-COCKADED WOODPECKER.

(*Dryobates borealis.*)

The red-cockaded woodpecker is an inhabitant of the Lower Austral zone of the Southeastern States from southern Virginia to eastern Texas and southern Missouri. Pine woods are its favorite haunts, and a large percentage of its food is obtained from pine trees. No complaints have yet been heard that this bird harms crops or forest trees, nor do the contents of its stomach indicate that such is the case. So far as known, it does not frequent orchards or cultivated land.

In the investigation of this bird's food 76 stomachs were available, taken in the four States of Alabama, Florida, Louisiana, and Texas. They were collected in every month except June and July. Of the total food 81.06 per cent was composed of insects, and the remainder, 18.94 per cent, of vegetable matter, mostly seeds of conifers.

Animal food.—Useful Coleoptera, i. e., carabids, were found in 7 stomachs, and amount to 0.53 per cent of the whole food. Other beetles, a large part of them the larvæ of wood-boring species, aggregate 10.49 per cent of the annual diet. Of these a number were weevils or snout beetles. Of the two identified beetles in the list which follows, the first belongs to the Chrysomelidæ or leaf-eating beetles; the other, *Trogosita virescens*, is one of the most beneficial species, since it preys upon the more destructive bark beetles and bark-boring grubs. Ants are evidently the favorite food. They were eaten in every month of which we have a record, and amount to a good percentage in each. December, with a percentage of 27.43, was apparently the month of least consumption, and September shows the maximum of 79 per cent, but we have hardly enough data to obtain final figures. The average for the year is 56.75 per cent, a record which is exceeded by that of only one other bird yet studied.

Hemiptera are eaten to the extent of 8.16 per cent of the food, and a good proportion of them are scales or bark lice. The others are mostly pentatomids or soldier-bugs. Nearly all were taken in the five months from December to April, inclusive, and two-thirds of them in December and January. These insects, and especially the pentatomids, are lovers of warm weather and sunshine, and many of them live on fruit. It seems probable that this bird gets them from their hibernating places. Grasshoppers, crickets, cockroaches, caterpillars, white ants (*Termes*), and spiders make up the rest of the animal food, 5.13 per cent. The cockroaches were in the form of their egg cases (oötheca).

The following is a list of insects identified in the stomachs:

COLEOPTERA.

Gastroidea sp.
Trogosita virescens.
Trogosita chloridea.
Tomicus cacographus.

HYMENOPTERA.

Ant (*Camponotus socius*).
Ant (*Cremastogaster læviuscula*).

HEMIPTERA.

Green tree bug (*Nezara hilaris*).

Vegetable food.—The greater part of the vegetable food consists of mast, mostly composed of the seeds of conifers. They were found in 26 of the 76 stomachs, and appear to be a somewhat regular article of diet, especially in the colder months. The total amount for the year is 11.13 per cent. Fruit pulp, poison-ivy seeds, bayberry seeds, seeds not identified, cambium, and rubbish each occurred in a few stomachs, and altogether amount to about 8 per cent of the food. Fruit pulp was found in 5 stomachs, but none of it could be further identified. Cambium was contained in 4 stomachs, and seeds of poison ivy in 1. Evidently this food has little economic interest.

The following seeds were identified in the food:

Bayberry (*Myrica carolinensis*).
Poison ivy (*Rhus radicans*).
Magnolia (*Magnolia fœtida*).
Pine (*Pinus* sp.).

Summary.—From this brief review of the food of the red-cockaded woodpecker it is evident that it does little if any damage by eating products of husbandry, and that it does good work in the forest by devouring wood-boring larvæ. No doubt it aids in distributing the seeds of the pines upon which it feeds.

NUTTALL WOODPECKER.

(*Dryobates nuttalli.*)

This bird is much like the downy in its quiet demeanor, its lack of fear of man, and its unobtrusive industry in searching for food. It is only a trifle larger than the downy, and its foraging and nesting habits are similar. Its range is practically confined to California, though it extends slightly beyond the boundaries at the northern and southern ends of the State.

The food of the Nuttall is much like that of the downy, the principal difference being in the relative proportions of the constituents. Only 53 stomachs of the Nuttall were available for examination—entirely too few to furnish final results, but enough to give an idea of the general character of the food. In the first analysis the food divides into 79.41 per cent of animal matter and 20.59 of vegetable. This differs but little from the record of the downy.

Animal food.—The largest item in the diet of the Nuttall consists of beetles of several families. The total for the year is 28.86 per cent. Of these the useful Carabidæ are barely represented. The remainder are divided among about a dozen families, of which the very harmful Cerambycidæ and Elateridæ in the larval stage are the most prominent. Ants amount to 8.19 per cent and are unevenly distributed, and the indications are that the stomachs are entirely too few to give trustworthy data on this item. Hymenoptera other than ants were eaten to the extent of 3.50 per cent. This again is not a reliable result, as nearly all of them were found in one stomach taken in December. Hemiptera, or bugs, amounted to 14.76 per cent. A few of these were scales and plant lice, but the majority were of the larger species. Two stomachs contained each between 30 and 40 box-elder bugs (*Leptocoris trivittatus*). These insects have a way of becoming very abundant at times and making a nuisance of themselves by invading buildings in search of winter quarters. Caterpillars stand third in the dietary of the Nuttall woodpecker and are eaten more regularly than any other food except beetles. They amount to 14.21 per cent. No special pest was identified, but some were evidently wood-boring species. A few flies, raphidians, pseudoscorpions, spiders, and millepeds make up the rest of the animal food, 9.89 per cent.

Following is a list of insects identified in the stomachs of the Nuttall:

COLEOPTERA.

Glyptoscelis albidus.
Gastroidea sp.
Blapstinus sp.
Balaninus sp.

HEMIPTERA.

Sinea diadema.
Leptocoris trivittatus.

ISOPTERA.

White ant (*Termes* sp.).

Vegetable food.—Fruit was eaten to the extent of 8.49 per cent. It was found in 15 stomachs, of which 2 contained rubus seeds; 5, elderberries; and the rest, pulp not further identified, except that in 1 stomach it was thought to be apple. Flower buds were found in 1 stomach. Poison oak (*Rhus diversiloba*) was noted in 9 stomachs, mast in 5, cambium in 2, and rubbish, etc., in 5. Altogether they amounted to 12.10 per cent, and made up the quota of vegetable food. None of them was eaten to a sufficient extent to be of any economic interest.

The following fruits were found in the stomachs:

Blackberry or raspberry (*Rubus* sp.).
Elderberry (*Sambucus glauca*).
Poison oak (*Rhus diversiloba*).

Summary.—In its animal food the Nuttall woodpecker is beyond criticism. Practically all of the insects eaten are either pests or of no positive benefit. While some fruit is eaten, it consists largely, and perhaps entirely, of wild varieties. Probably the worst that can be said of the bird is that it helps in the distribution of poison-oak seeds.[1]

THREE-TOED WOODPECKERS.

(*Picoides arcticus* and *P. americanus.*)

The three-toed woodpeckers are residents of the Boreal zones of North America, in Alaska, Canada, the northeastern United States, and in the mountains of the Western States, south to southern New Mexico and to central California. The two species, including the two subspecies of *americanus*, are so similar in habits that they may be treated together. All are residents of coniferous forests, from which they sometimes wander a short distance in winter. The trunks of scaly-barked conifers, such as spruces, hemlocks, tamaracks, and lodgepole pines, are their favorite hunting grounds, and here they excavate burrows in which they rear their young and find shelter at night.

In their choice of food these two species are as closely allied as in other respects. The great bulk consists of the larvæ of wood-boring beetles or moths. These are eaten with great regularity throughout the year, but somewhat more in the colder months than in summer. In the dead of winter, when all insect life is apparently quiescent, these birds still obtain their daily food. Flies and bees no longer sport in the sunshine; butterflies and flowers are replaced by sleet and snow; the beetles are either dead or snugly ensconced in crevices in the bark, awaiting the return of warmth, while the larvæ repose in their burrows of solid wood, apparently safe from all disturbance. But undaunted by cold and undeterred by hard work, our intrepid little friends tear open the secure retreats in the bark, or chisel into the solid wood, and feast upon the luckless insects.

Unfortunately only 28 stomachs of *Picoides arcticus* and 23 of *P. americanus* were available for examination. There are few birds which eat more of the pests of the forests than do the three-toed woodpeckers; and while we have no doubt determined the principal food factors, there are many minor questions for the solution of which additional material is necessary.

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[1] Another species of Dryobates (*D. arizonæ*), of which no stomachs have been received, inhabits the mountains from northeastern Arizona and northwestern New Mexico south into Mexico.

In the first analysis the food divides into 88.69 per cent of animal matter to 11.31 of vegetable for *arcticus*, and 94.06 per cent of animal to 5.94 of vegetable for *americanus*. The largest item with both species is wood-boring coleopterous larvæ. These amount to 64.25 per cent with *arcticus* and 60.66 with *americanus*. Caterpillars, which in this case are mostly wood-boring species, amount to 12.88 and 14.45 per cent for the two bird respectively. The total of wood-boring larvæ, including both caterpillars and beetles, is 77.13 per cent for *arcticus* and 75.11 per cent for *americanus*, or more than three-fourths of the food of each species. Stomachs containing 15 to 20 of these grubs are very common, and one held 34. Probably the stomach is filled several times each day, and it does not seem unreasonable to assume that a bird will eat 50 of these insects every 24 hours for 6 months and at least 25 daily for the other half of the year. At this rate one bird will annually destroy 13,675 of these destructive grubs. If this assumption be true, the birds of these two species must destroy an immense quantity of wood-boring insects, even if they do not cause any perceptible diminution in their numbers. Beetles other than wood-borers amount to 3.41 per cent for *arcticus* and 10.39 for *americanus*. A considerable proportion of these were weevils, including quite a number of engravers (Scolytidæ). They are, however, eaten so irregularly as to indicate that they are taken only incidentally and are not sought, as are the wood-boring grubs. Ants constitute 6.35 per cent of the food of *arcticus* and 8.29 of that of *americanus*. None of these were taken in winter, and most of them were eaten in spring and summer. The Picoides do not belong to the ant-eating group of woodpeckers. A few other insects and spiders amount to less than 1 per cent for each species and make up the remainder of the animal food.

Vegetable food.—Vegetable matter constitutes 11.31 per cent of the stomach contents of *arcticus* and 5.94 per cent of that of *americanus*. It can all be included in four items: Fruit, mast, cambium, and rubbish. Fruit skins were found in only 1 stomach of *americanus* and mast in but 1 stomach of *arcticus*. Cambium was found in 10 stomachs of *arcticus* and 8 of *americanus*. This indicates that these birds do some pecking at the bark of living trees for other purposes than getting insects, but no complaints have yet been made, from which we infer that little or no damage is done; in fact the amount contained in the stomachs is not large, a little less than 10 per cent. Rubbish, consisting principally of rotten wood, was found in 9 stomachs. Where a bird pecks wood as much as do these, it is no wonder that some of it is swallowed with the grubs that are embedded therein.

Summary.—The foregoing discussion of the food of the two species of Picoides shows that these birds act as "conservators of the forest" in the strongest sense. Three-fourths of their food consists of the direst enemies of forest trees. In the Report on Forest Insects by the United States Entomological Commission, some 25 species of cerambycid and buprestid beetles are noted as preying upon the ash tree and 35 upon the pine. Since the family Cerambycidæ contains upward of 7,500 species, of which 600 are found in America, since all pass their larval stage within the substance of some tree or woody plant, and since many remain in the larval state two or three years, evidently they inflict upon forest trees and other plants an immense amount of damage. Probably there are not many other agencies more destructive to timber than this family of beetles. Nor is timber safe even after it has been cut. Logs lying in the mill yard or forest may be ruined in a single season if these creatures are not prevented from depositing their eggs. So long do some of these larvæ live in the wood that they sometimes emerge after it has been converted into furniture and passed into household use. A very efficient check upon the undue increase of these insects is found in the woodpeckers, especially the two species of Picoides. In orchards, or in parks, it may be easy to combat insect enemies by insecticides or other artificial means, but in the forest this is more difficult and expensive, and it behooves the forester to take advantage of all helpers which Nature has provided; among these, insectivorous birds must take high rank. It is unfortunate that in most places three-toed woodpeckers are not as numerous as many other species, and for this reason they should be protected and encouraged in every possible way.

YELLOW-BELLIED WOODPECKER OR SAPSUCKER.

(*Sphyrapicus varius* and subsp.)

The yellow-bellied woodpecker or sapsucker (Pl. II) is probably the most migratory of all our woodpeckers. It breeds throughout the whole of southern Canada from ocean to ocean and thence southward to northeastern California, western Texas, northern Missouri, northern Ohio, and Massachusetts, and in the mountains south to North Carolina. It winters from near the southern limit of the breeding range south to Mexico, Cuba, and Costa Rica.

It is to this species that the term sapsucker is most often and most justly applied, for it drills holes in the bark of certain trees and drinks the sap. It feeds also on cambium, insects, and wild fruits and berries.

In writing of the habits of these woodpeckers in northern New York, in 1878, Dr. Merriam states:

> They really do considerable mischief by drilling holes in the bark of apple, thornapple, and mountain ash trees in such a way as to form girdles of punctures, sometimes 2 feet or more in breadth (up and down), about the trunks and branches. * * * The holes, which are sometimes merely single punctures, and sometimes squarish spaces (multiple punctures) nearly half an inch across, are placed so near together that not infrequently they cover more of the tree than the remaining bark. Hence, more than half of the bark is sometimes removed from the girdled portions, and the balance often dries up and comes off. Therefore it is not surprising that trees which have been extensively girdled generally die, and mountain ash are much more prone to do so than either apple or thornapple trees, due, very likely, to their more slender stems.[1]

The late Frank Bolles has published some interesting detailed observations respecting the food habits of the sapsucker. His conclusions are:

> That the yellow-bellied woodpecker is in the habit for successive years of drilling the canoe birch, red maple, red oak, white ash, and probably other trees, for the purpose of taking from them the elaborated sap, and in some cases parts of the cambium layer; that the birds consume the sap in large quantities for its own sake and not for insect matter which such sap may chance occasionally to contain; that the sap attracts many insects of various species, a few of which form a considerable part of the food of this bird, but whose capture does not occupy its time to anything like the extent to which sap drinking occupies it; * * * that the forest trees attacked by them generally die, possibly in the second or third year of use.[2]

Mr. Bolles shot 8 sapsuckers in July and August, 1890. Their stomachs "were well filled with insects." Some of these were examined by Mr. Samuel H. Scudder, who states:

> The insects in the different stomachs are in all cases almost exclusively composed of the harder chitinous parts of ants. In a cursory examination I find little else, though one or two beetles are represented, and No. 4 must have swallowed an entire wasp of the largest size, his head and wings attesting thereto.[3]

Mr. Bolles proved by experiment that concentrated sap (saturated with sugar) is not sufficient to sustain life, even with the addition of a small percentage of insects. The logical inference is that sap, while liked by the birds and consumed in large quantities, holds a subordinate place as an article of food.

J. Maurice Thompson says of the sapsucker:

> Its food is sap or juices of green trees. It eats nothing else. * * * The principal trees from which it obtains its food are the maples, hickories, cedar, apple, pear, southern pine, and swamp ash.[4]

In speaking of this species Dr. Hopkins mentions the finding of a small pitch pine tree that had recently died from injuries by woodpeckers. The bird evidently attacks the healthy tree for the sole purpose of feeding on the inner bark. Thus, instead of destroying insects, it made the conditions favorable for the attack of bark beetles and other insects which had bred in the bark and wood in considerable numbers. To anticipate the possible conclusion that the woodpecker intended to thus trap the insects and return to eat them, Dr. Hopkins added that at the time the observations were made, the insects had not been molested.[1]

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[1] Bull. Nuttall Ornith. Club, IV, 3-5, January, 1879.

[2] Auk, VIII, 270, July, 1891.

[3] Auk, VIII, 269, July, 1891.

[4] Appleton's Journal, VIII, 631, Dec. 7, 1872.

This investigation of the food of the yellow-bellied sapsucker is based upon examination of the contents of 313 stomachs, collected in 24 States, Canada, and the District of Columbia, and distributed over 12 months of the year. Of this food 49.31 per cent is animal matter and 50.69 vegetable. This is the first species discussed in which the vegetable part of the diet is greater than the animal. This is true of 5 of the 16 species under consideration.

Animal food.—Useful beetles, i. e., predaceous ground beetles and ladybirds (Coccinellidæ), are eaten by the sapsucker to the extent of only 0.91 per cent of the whole food. Other beetles amount to 4.54 per cent, and are made up of weevils, dung beetles (*Aphodius*), and click beetles, with a few cerambycid larvæ. Ants amount to 34.31 per cent of the whole food, or 69 per cent of the animal part. They are evidently favorite food, being eaten quite regularly through the year, although the months from May to August, inclusive, show the highest percentages, averaging over 68 per cent. Other Hymenoptera amount to 2.64 per cent, and are very irregularly taken. October appears to be the month of greatest consumption, with 15.07 per cent. Hemiptera are eaten very sparingly. Scales (Coccidæ) were found in two stomachs, and in one were identified as the plum scale (*Eulecanium cerasifex*); these, with a few stink bugs, amount to a little less than 1 per cent for the year. A few miscellaneous insects and spiders aggregate 5.44 per cent. The insects consist of May flies, stone flies, grasshoppers, crickets, tree hoppers, caterpillars and moths, and flies (Diptera). A few eggs were found, probably those of the tent caterpillars (*Malacosoma*).

The following is a list of insects identified in the stomachs:

COLEOPTERA.

Coccinella 9-notata.
Coccinella sanguinea.
Adalia bipunctata.
Anatis sp.
Læmophlæus biguttatus.
Onthophagus sp.
Aphodius fimetarius.
Aphodius inquinatus.
Dichelonycha sp.
Xanthonia 10-notata.
Diabrotica 12-punctata.
Canifa pallipes.
Pandeletejus hilaris.
Balaninus sp.

HYMENOPTERA.

Vespa maculata.
Vespa arenaria.
Pimpla sp.

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[1] Hopkins, A. D., Bull. 56, West Virginia Agric. Exper. Sta., p. 355, 1899.

HEMIPTERA.

Plum or cherry scale (*Eulecanium cerasifex*).

LEPIDOPTERA.

Tent caterpillar (*Malacosoma* sp.).

Vegetable food.—The two principal items of vegetable food are fruit and cambium. Twenty-two species of wild fruit and two of cultivated were identified. In general the least fruit is eaten in spring and summer and the most in fall and winter. Altogether it was found in 118 stomachs, none in May and the most, 71.26 per cent, in November. It was evidently mainly berries left on the bushes. Seeds of Rubus fruit, which may be either wild or cultivated, were found in two stomachs, and two contained what was thought to be apple pulp. The total of the fruit is 28.06 per cent of the food, but evidently has little economic interest. The apple was probably the only cultivated variety and this was eaten only twice. Cambium, or the inner bark of trees, was eaten every month, but mostly in winter and spring. The greatest consumption is in April, 48.95 per cent, and the least in November, 1.53 per cent. It was found in 127 stomachs and was the entire contents of 12. The average for the year is 16.54 per cent, which is exceeded by only two items—fruit and ants. The subjects of cambium and sap sucking have been discussed on a previous page. Mast, poison Rhus seeds, mullein, and rubbish collectively make up the remaining 6.09 per cent. Mast was found in 15 stomachs, and is evidently not specially sought. Poison ivy seed was contained in seven stomachs and poison sumac in one, so the sapsucker does little harm by distributing the seed of these noxious plants. Rubbish was found in 48 stomachs. It was mostly bits of the outer bark of trees, evidently swallowed when pecking for cambium.

The following fruits and seeds were found in the food:

Red cedar (*Juniperus virginiana*).
Greenbrier (*Smilax* sp.).
Hackberry (*Celtis occidentalis*).
Sassafras (*Sassafras sassafras*).
Blackberry or raspberry (*Rubus* sp.).
Shad or service berry (*Amelanchier canadensis*).
Choke cherry (*Prunus virginiana*).
Black cherry (*Prunus serotina*).
Poison sumac (*Rhus vernix*).
Poison ivy (*Rhus radicans*).
American holly (*Ilex opaca*).
Ink berry (*Ilex glabra*).
Swamp holly (*Ilex decidua*).
Black alder (*Ilex verticillata*).
Burning bush (*Euonymus americanus*).
Frost grape (*Vitis cordifolia*).
Virginia creeper (*Parthenocissus quinquefolia*).
Flowering dogwood (*Cornus florida*).
Sour gum (*Nyssa sylvatica*).
Blueberry (*Vaccinium* sp.).
Black nightshade (*Solanum nigrum*).
Mullein (*Verbascum thapsus*).
Red-berried elder (*Sambucus pubens*).
Elder (*Sambucus* sp.).
Poke berry (*Phytolacca decandra*).

Summary.—In the animal food of the yellow-bellied sapsucker, ants are the most important item, and while of no great economic interest they must be reckoned in the bird's favor. On the other hand, the damage this sapsucker inflicts in eating the cambium and sap of trees is so serious that it more than counterbalances any good that the bird does in other directions. Investigations show that the damage to timber, especially in the Southern States, is extensive and serious.[1]

RED-BREASTED SAPSUCKER.

(*Sphyrapicus ruber* and subsp.)

The red-breasted sapsucker is confined to the Pacific coast region, and ranges from central Lower California in winter, north in summer through California, Oregon, and Washington to Alaska. Naturally it seems to be a forest bird, but it takes kindly to orchards and ranches. It is migratory to a slight extent, but summers as far south as the San Bernardino Mountains. It makes, however, a minor migration in many localities by descending the mountains to the valleys, in which it winters.

Speaking guardedly of this bird, Maj. Charles Bendire says:

> I am inclined to think that this species does not indulge in the habit of girdling trees for the sap and the soft inner bark (cambium) to the same extent that *Sphyrapicus varius* does; at any rate, not during the breeding season.[2]

On the other hand, Prof. Cook, of Claremont, California, gives the following direct testimony:

> *Sphyrapicus ruber* is the sapsucker of southern California. It taps fruit trees, especially prune and apricot, and evergreens. Its mischief seems much more serious than that of its congener of the East, as trees are frequently killed by reason of its punctures, although these latter are more distant and less numerous. I never knew a tree to be killed by the sapsuckers in Michigan. The evil in California is wrought in summer, when the dry season has enfeebled the tree, and this is a possible explanation of the more serious harm to the trees of this region.[3]

In the face of this conflicting testimony we may infer that the habits of the bird vary with the locality.

In Oregon the writer observed trees of white birch and mountain ash growing in a village yard which were badly injured by this bird.

Only 34 stomachs of this species were available for examination, and none were taken in the months from April to August, inclusive, while 29, or five-sixths of all, were collected in October, November, and December. Only some general ideas of the food can be expected from so little material.

In the first analysis we find practically 69 per cent of animal food to 31 of vegetable.

Animal food.—This species is a much greater insect eater than *S. varius*. Ants, the largest item, amount to 42.49 per cent. They were eaten freely in every month in which stomachs were taken except February, and 4 stomachs contained nothing else. Other Hymenoptera aggregate a little more than 7 per cent. Beetles of all kinds amount to only 4 per cent, and none of them are of useful species. The greater number belong to the family Chrysomelidæ, or leaf-eaters. *Diachus auratus* was the only one identified. One stomach contained the remains of *Rhinosimus pallipes*, a member of the Pythidæ, a small and rather rare family. Caterpillars were found in 2 stomachs, locust eggs in 1, and a caterpillar formed the entire contents of 1. All these amount to 15 per cent, and make up the rest of the animal food.

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[1] A bulletin upon this subject is in preparation by W. L. McAtee.

[2] Bendire, Maj. Charles, Life Histories of North American Birds, II, 94, 1895.

[3] Cook, A. J., Auk, XIII, 85, 1896.

Vegetable food.—Of the vegetable food, fruit constitutes 12.69 per cent. Berries of the pepper tree (*Schinus molle*) were found in 3 stomachs, cascara (*Rhamnus californicus*) in 1, pulp not further identified in 3, and figs in 1. Only the last is of any economic importance. Seeds of poison oak were found in 4 stomachs, wax myrtle (*Myrica californica*) in 1, and unidentified seeds in 1. Seeds altogether amount to 5.96 per cent. Cambium was found in only 6 stomachs, but aggregated 11.13 per cent, which is three-fourths as much as was eaten by *S. varius*. Nearly all that had taken it at all had eaten a good percentage. Stomach examinations alone do not enable us to settle the status of the bird, for which more material and some field observation will be necessary.

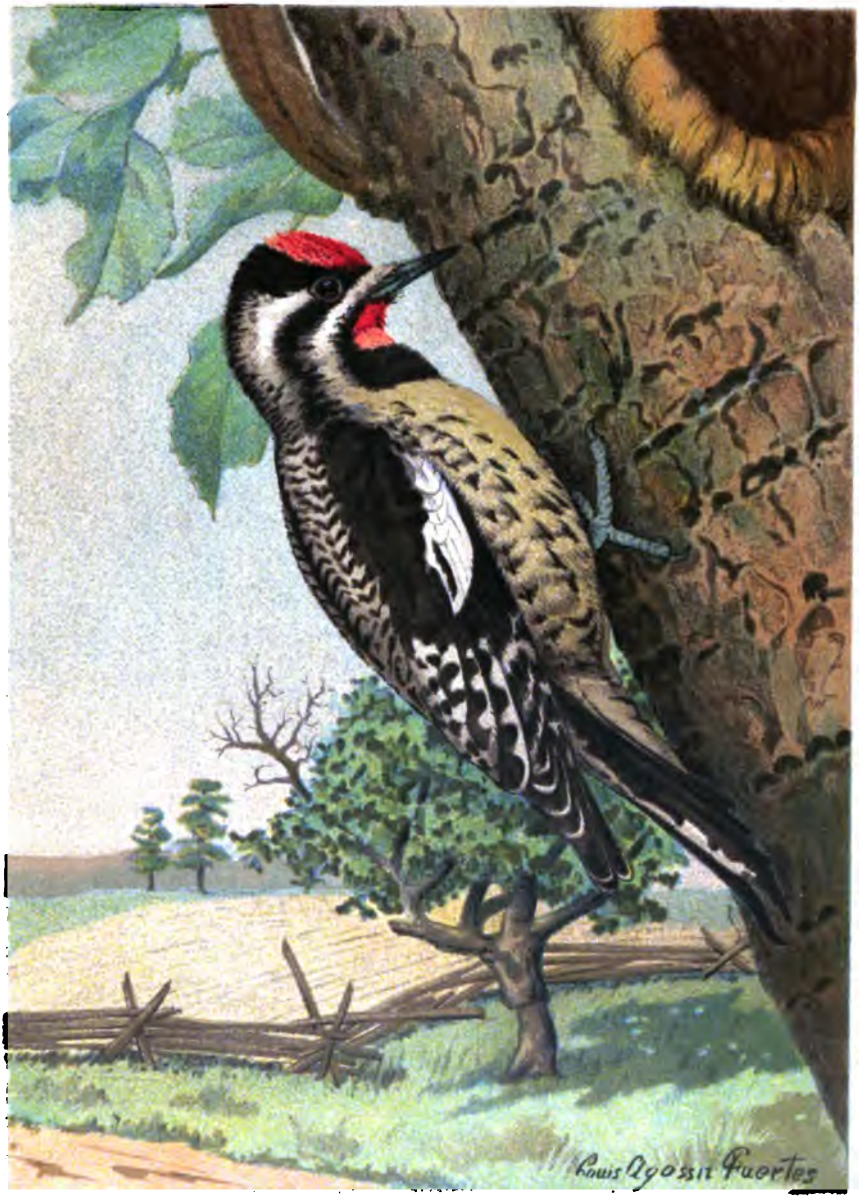
Summary.—It appears that the red-breasted sapsucker attacks and injures trees, but whether it is as destructive as its eastern relative is not yet known, and more material and further observations are necessary to settle the question.

WILLIAMSON SAPSUCKER.

(*Sphyrapicus thyroideus.*)

The Williamson sapsucker is a bird of mountains and evergreen forests. Its range extends from the eastern slope of the Rocky Mountains westward to the Pacific, and from Arizona and New Mexico northward to British Columbia; south in winter to Mexico. The bird is likely to be of little economic interest except in connection with forests. Only 17 stomachs of this species have been received by the Biological Survey, and all but 2 of these were collected in the months from June to September, inclusive. Conclusions based on the examination of so little material must be considered as only tentative. In the first analysis of the food it divides into 87 per cent of animal matter and 13 of vegetable.

Animal food.—Of the animal food a mere trace was shown of click-beetles (Elateridæ) and less than 1 per cent of crane flies (Tipulidæ). The remainder, 86 per cent, consists entirely of ants, with which 7 stomachs were entirely filled. This record places this bird at the



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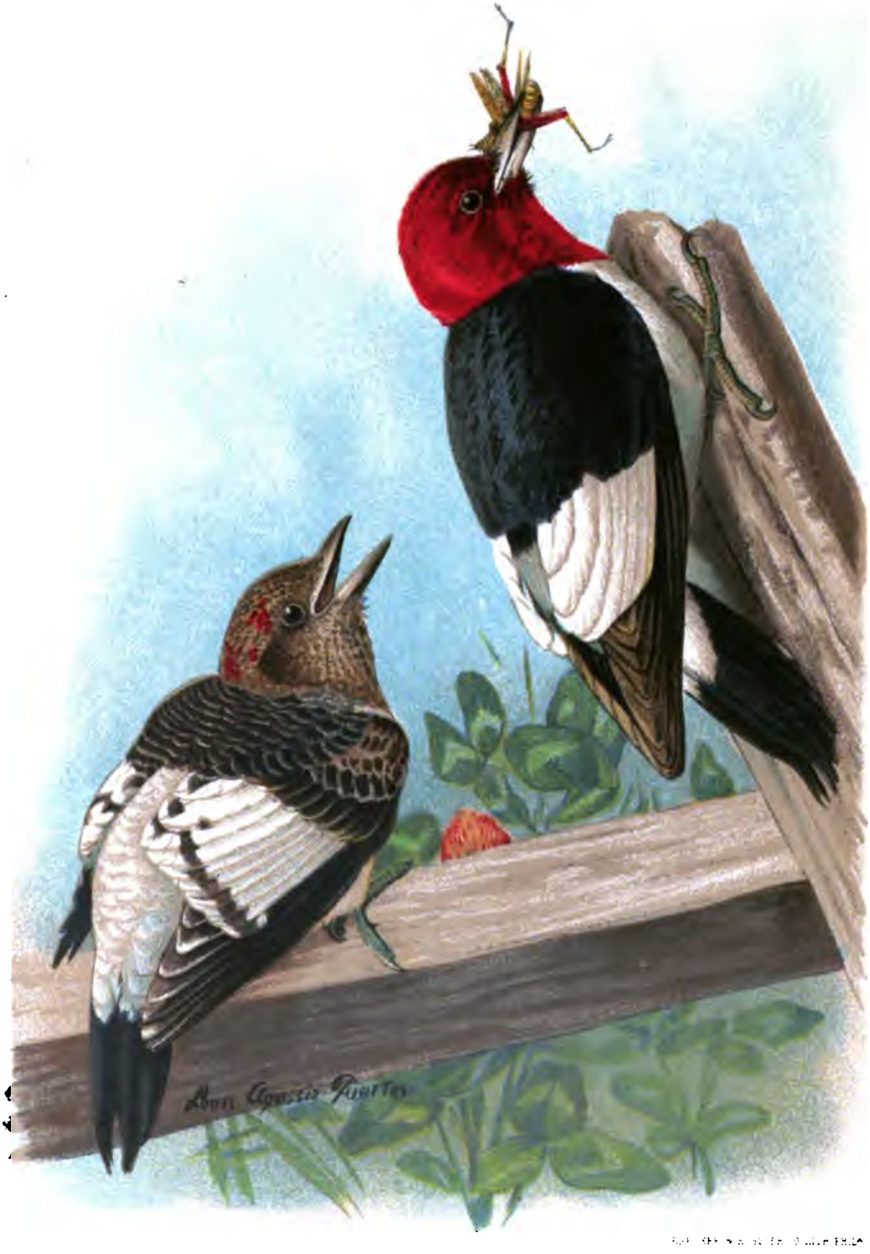
YELLOW-BELLIED SAPSUCKER.



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RED-HEADED WOODPECKER (ADULT AND YOUNG).

head of the woodpeckers in ant eating, but the material is too scanty to warrant final conclusions.

Vegetable food.—Fruit pulp in 1 stomach and rubbish in another, each amounted to less than 1 per cent of the year's food. Cambium occurred in 5 stomachs, and formed the bulk of the vegetable food, 12.55 per cent of the whole.

Summary.—These results would indicate a very limited diet for this bird, but it is altogether probable that a greater number of stomachs would materially modify these figures. They show, however, that the bird eats ants and cambium, if they are not conclusive as to what it does not eat.

PILEATED WOODPECKER.

(*Phlœotomus pileatus* and subspp.)

The pileated woodpecker, logcock, woodcock, or cock of the woods, as it is variously called, is the largest member of the family now living in the United States, except the ivory-billed woodpecker, which is very rare. The logcock is essentially a forest bird, and is rarely found except in rather extensive tracts of timber. It is usually shy and retiring, difficult to approach, and better known by its work than by sight. Its large size, loud voice, and habit of hammering upon dead limbs combine to make it a conspicuous inhabitant of the forest. Its strength is wonderful, and it is hard to believe that a bird can so completely destroy a stump or log. Strips of decayed wood 2 feet long, 4 inches wide, and an inch thick are often torn from a stump and thrown several yards away.

Woodpeckers signal each other by hammering upon a dead and hollow limb or trunk of a tree, or upon the metallic cornice of a building. The pileated is an adept at such telegraphing, and its tattoo on a particularly resonant piece of timber can be heard for more than a mile.

The pileated woodpecker seems to be distributed over the United States in general, and north to Canada, but is absent from some large areas, particularly in the southwestern United States, even where there are extensive forests and other conditions apparently suited to its tastes. It is not migratory in the usual sense, but in winter wanders extensively, usually accompanied by its mate, which leads to the belief that it mates for life.

In the laboratory investigation of this bird's food 80 stomachs were available. They were collected in 14 States, the District of Columbia, and Canada, and are distributed in every month, though May is represented by only 1. The animal food amounts to 72.88 per cent and the vegetable to 27.12. The former consists principally of beetles and ants, and the latter of wild fruits.

Animal food.—Beetles amount to 22.01 per cent. Nearly all were in the larval stage, and evidently were dug out of dead and decaying wood. They belong to the Cerambycidæ, the Buprestidæ, and the Elateridæ, all of them wood-borers, with some Lucanidæ and Scarabæidæ, many species of which breed in rotting timber. Carabidæ, or useful ground-beetles, were found in only 6 stomachs and amount to a small fraction of 1 per cent.

Ants aggregate 39.91 per cent and constitute more than half of the animal food. They were found in 48 stomachs, and in one, 2,600 were counted; in another, 2,080; and in a third, 2,000. They are mostly of the larger species that live in decaying timber. These two items, beetles and ants, make up the bulk of the animal food, 61.92 per cent. It is evident that they are the objects of the bird's search when he is foraging over the trunks of dead trees or logs, and that other insects are taken only incidentally. Flies, caterpillars, fragments of cockroaches and their egg cases (oötheca), bits of grasshoppers, some sawflies, and white ants, no one of which amounts to a respectable percentage, aggregate 10.96 per cent, the balance of the animal food.

The following is a list of insects identified in the stomachs:

COLEOPTERA.

Anisodactylus sp.
Allorhina nitida.
Cyclocephala sp.
Upis ceramboides.
Chalcophora sp.

HYMENOPTERA (ANTS).

Camponotus pennsylvanicus.
Camponotus herculeanus.
Cremastogaster læviuscula.

LEPIDOPTERA.

Caterpillar (*Scolecocampa liburna*).

Vegetable food.—The largest item of vegetable food, and in fact the only one of importance, is wild fruit, which amounts to 22.56 per cent, and of which 19 species were identified. This is probably eaten in every month, but in the stomachs examined none was found in April, May, or June; but as only 6 stomachs were collected in those months, the record is not conclusive. The only part of the fruit which can possibly have any economic interest is some Rubus seeds found in 1 stomach and some unidentified seeds in 5, but probably these were wild like the others. Seeds of poison ivy (or poison oak), poison sumac, dwarf sumac, a little cambium, and mast, with some rubbish, altogether amount to 4.56 per cent and complete the vegetable food.

The following vegetable food was found in the stomachs:

Greenbrier (*Smilax glauca*).
Cat brier (*Smilax rotundifolia*).
Laurel-leaved greenbrier (*Smilax laurifolia*).
Hackberry (*Celtis occidentalis*).
Sassafras berry (*Sassafras sassafras*).
Blackberry or raspberry (*Rubus* sp.).
Dwarf sumac (*Rhus copallina*).
Poison sumac (*Rhus vernix*).
Poison ivy (*Rhus radicans*).
American holly (*Ilex opaca*).
Dahoon holly (*Ilex cassine*).
Frost grape (*Vitis cordifolia*).
Woodbine (*Parthenocissus quinquefolia*).
Flowering dogwood (*Cornus florida*).
Rough-leaved dogwood (*Cornus asperifolia*).
Sour gum (*Nyssa sylvatica*).
Tupelo gum (*Nyssa aquatica*).
Persimmon (*Diospyros virginiana*).
Fringe tree (*Chionanthus virginica*).
Elderberry (*Sambucus canadensis*).
Larger withe-rod (*Viburnum nudum*).
Black haw (*Viburnum prunifolium*).

Summary.—The food of the pileated woodpecker does not interest the farmer or horticulturist, for it is obtained entirely from the forest or the wild copses on its edge. This bird does not visit either the orchard or the grain field, and all its work in the forest helps to conserve the timber. Unfortunately the bird is so scarce in many places that it is an object of curiosity, and the man or boy with a gun never lets pass a chance to shoot one, although its flesh is unfit for food. In fall and winter it may often be seen in the market in Washington, and probably in cities farther south. Maj. Bendire relates that once when short of provisions he attempted to eat one, but found it extremely unpalatable. Its killing should be strictly prohibited at all times.

RED-HEADED WOODPECKER.

(*Melanerpes erythrocephalus.*)

The handsome redhead (Pl. III) inhabits suitable localities throughout most of southern Canada and the United States east of the Rocky Mountains, but is rare in New England and northeastward. It is a familiar bird on telegraph poles and fence posts and feeds largely on insects found upon these bare surfaces, but the vegetable matter in its stomach shows that it forages elsewhere also.

Fifty years ago Giraud stated that on Long Island the red-headed woodpecker arrives early in April, and during the spring "subsists chiefly on insects. In summer it frequents fruit trees, ripe cherries and pears seeming to be a favorite repast. In the fall it feeds on berries and acorns, the latter at this season forming a large portion of its food."[1]

In its fondness for mast it resembles its relative, the California woodpecker. In the northern part of its range, where the oak is replaced by the beech, the redhead makes the beechnut its principal food. Dr. C. Hart Merriam has given much testimony under this head.[2] He states that in northern New York, where it is one of the commonest woodpeckers, it subsists almost exclusively on beechnuts during the fall and winter, even picking the green nuts before they are ripe and while the trees are still covered with leaves. He has shown that these woodpeckers invariably remain throughout the winter after good nut yields and migrate whenever the nut crop fails. He says: "Gray squirrels, red-headed woodpeckers, and beechnuts were numerous during the winters of 1871–72, 1873–74, 1875–76, 1877–78, 1879–80, 1881–82, 1883–84, while during the alternate years the squirrels and nuts were scarce and the woodpeckers altogether absent;" and adds that in Lewis County, N. Y., "a good squirrel year is synonymous with a good year for *Melanerpes*, and vice versa." In early spring following a nut year, when the melting snow uncovers the ground, they feed on the beechnuts that were buried during the winter. On April 5, 1878, at Locust Grove, N. Y., he shot 6 whose gizzards contained beechnuts and nothing else.

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[1] Giraud, J. P., Birds of Long Island, p. 180, 1844.

[2] Birds of Connecticut, p. 66, 1877; Bull. Nuttall Ornith. Club, III, 124, 1878; Mammals of the Adirondacks, p. 226, 1884.

In an interesting article in the Auk,[1] Mr. O. P. Hay says that in central Indiana during a good beechnut year, from the time the nuts began to ripen, the redheads were almost constantly on the wing, passing from the beeches to some place of deposit. They hid the nuts in almost every conceivable situation. Many were placed in cavities in partly decayed trees; and the felling of an old beech was certain to provide a feast for the children. Large handfuls were taken from a single knot hole. They were often found under a patch of raised bark, and single nuts were driven into cracks in the bark. Others were thrust into cracks in gateposts; and a favorite place of deposit was behind long slivers on fence posts. In a few cases grains of corn were mixed with beechnuts. Nuts were often driven into cracks in the ends of railroad ties, and the birds were often seen on the roofs of houses pounding nuts into the crevices between the shingles. In several instances the space formed by a board springing away from a fence was nearly filled with nuts, and afterwards pieces of bark and wood were brought and driven over the nuts as if to hide them from poachers.

In summer Dr. Merriam has seen the redheads "make frequent sallies into the air after passing insects, which were almost invariably secured." He has also seen them catch grasshoppers on the ground in a pasture.

Dr. A. K. Fisher saw several red-headed woodpeckers feeding on grasshoppers in the streets at Miles City, Mont., in the latter part of July, 1893. Several of the birds were seen capturing these insects near the hotel throughout the greater part of the forenoon. From a regular perch on top of a telegraph pole or cottonwood they descended on their prey, sometimes eating them on the ground, but more often returning to their former post to devour them.

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[1] Auk, IV, 194, 195, 1887.

The following interesting observation was made by Dr. G. S. Agersborg, of Vermilion, S. Dak.:[1]

> Last spring, in opening a good many birds of this species with the object of ascertaining their principal food, I found in their stomachs nothing but young grasshoppers. One of them, which had its headquarters near my house, was observed making frequent visits to an old oak post, and on examining it I found a large crack where the woodpecker had inserted about 100 grasshoppers of all sizes (for future use, as later observation proved), which were put in without killing them, but they were so firmly wedged in the crack that they in vain tried to get free. I told this to a couple of farmers, and found that they had also seen the same thing, and showed me posts which were used for the same purpose. Later in the season the woodpecker whose station was near my house commenced to use his stores, and to-day (February 10) there are only a few shriveled-up grasshoppers left.

The late Mr. Charles Aldrich, of Webster City, Iowa, states that he saw a red-headed woodpecker catching grasshoppers on the prairie half a mile from timber. In Nebraska grasshoppers were found in 4 out of 6 stomachs examined by Prof. Samuel Aughey.

Besides taking fruit and grain, this woodpecker has been accused of destroying the eggs of other birds and even of killing the young; and from Florida comes a report that it enters poultry houses and sucks the eggs of domestic fowls. Mr. Charles Aldrich, of Webster City, Iowa, says that a red-headed woodpecker was seen to kill a duckling with a single blow on the head, and then to peck out and eat the brains.[2] In view of such testimony, remains of eggs and young birds were carefully looked for in the stomachs examined, but pieces of eggshell were found in only 4.

A very unusual trait has been recorded by Dr. Howard Jones, of Circleville, Ohio. He has seen the red-headed woodpecker steal the eggs of eaves swallows, and in cases where the necks of the nests were so long that the eggs were out of reach, the woodpecker made a hole in the walls of the nest and so obtained the contents. In a colony of swallows containing dozens of nests, not a single brood of young was raised. One of the woodpeckers also began to prey upon hens' eggs, and was finally captured in the act of robbing the nest of a sitting hen.[3]

The redhead has been accused of doing considerable damage to fruit and grain, and both charges are fairly well sustained. In northern New York Dr. Merriam has seen it peck into apples on the tree, and has several times seen it feed on chokecherries (*Prunus virginiana*).

Mr. August Jahn, of Pope County, Ark., writes that it has damaged his corn to the amount of $10 or $15, and Dr. J. R. Mathers, of Upshur County, W. Va., says that the same species feeds on cherries, strawberries, raspberries, and blackberries, and that its depredations are sometimes serious. According to Mr. Witmer Stone, of Germantown, Pa., red-headed woodpeckers have been observed to strip a blackberry patch of all of its fruit. Mr. W. B. McDaniel, of Decatur County, Ga., also reports that the sapsucker and redhead eat grapes and cherries, the loss being sometimes considerable. These examples show the nature of the testimony contributed by eyewitnesses, the accuracy of whose observations there is no reason to doubt. That the stomach examinations do not reveal more damaging evidence against the species is not surprising, for a person seeing a bird eating his choice fruit, or in some other way inflicting damage, is more impressed by it than by the sight of a hundred of the same species quietly pursuing their ordinary vocations. Thus an occasional act is taken as a characteristic habit.

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[1] Bull. Nuttall Ornith. Club, III, 97, 1878.

[2] Am. Nat., VI, 308, May, 1877.

[3] Ornithologist and Oologist, VIII, 56, 1883.

In the food investigation of the redhead 443 stomachs were examined. They were collected in 27 States, the District of Columbia, and Canada, and represent every month, though fewer were taken in the colder season, as the bird is inclined to migrate, and remains in the north only when an abundance of food is assured. Of the stomach's contents, animal matter amounts to 33.83 per cent and vegetable to 66.17.

Animal food.—Beetles amount to about 19 per cent of the food. Of these, 7.34 per cent consist of predaceous ground beetles and tiger beetles, with a few ladybird beetles, all of which are useful. This is the highest percentage of useful insects eaten by any of the woodpeckers. Among the species taken are the fire ground-beetle (*Calosoma calidum*) and the searcher (*C. scrutator*), both predaceous species of large size and vile odor.

Passalus cornutus, one of the staghorns, a large species, was also found, as well as a pair of mandibles belonging to *Prionus imbricornis*, one of the largest species in the United States. The remainder of the beetle food is made up of various families, of which the May beetles (Scarabæidæ) are the most prominent. They amount to 6.31 per cent and are mostly flower-beetles (*Euphoria*) or closely allied genera. A preference for large beetles is a pronounced characteristic of this woodpecker. Weevils were found in 99 stomachs and as many as 12 were counted in one. Such harmful species as *Epicærus imbricatus*, *Phytonomus punctatus*, and *Sphenophorus zeæ* were identified in several stomachs. The beetles eaten by the redhead are mostly adults, and such species as creep over the bark of trees or on bare fences or telegraph poles, where the bird loves to forage. Unlike the hairy, downy, and three-toed woodpeckers, the redhead eats very few beetle larvæ or other grubs, or ants that live in wood or other places of concealment. Apparently it is not so fond of pecking wood as are the other species, but on the other hand it has been known to peck holes in telegraph and telephone poles until they were so weakened as to break down, thereby causing "considerable damage."[1]

Ants amount to 5.17 per cent of the food of the redhead, which is the lowest record but one of all the woodpeckers. The greatest number are eaten in June and July, when they aggregate a little more than 14 per cent in each month. As they are mostly taken in the warmer months, it is almost certain that they are captured in the open, not dug out of decaying trees or logs. Hymenoptera other than ants amount to 1.63 per cent. These are of course bees and wasps, and, as this bird is quite skillful in catching insects upon the wing, probably it takes most of them in the air.[2] In one stomach was found one worker honey bee. Parasitic species were identified in a few stomachs. Like the ants, most of the wasps were taken in midsummer.

Hemiptera, or bugs, are a small but rather regular constituent of the food. They aggregate only 1.89 per cent of the yearly diet, but include some interesting species. A collection of 6 stomachs was received from Ames, Iowa, at a time when a brood of 17-year locusts (*Tibicen septendecim*) was out. These insects had been eaten by every one of the birds, and they averaged 52 per cent of the stomachs' contents. Field observation, as well as stomach examination, shows that cicadas are eaten in their season by all kinds of insectivorous birds big enough to manage such large insects. Cicadas were found in 10 stomachs, but not all were identified as the 17-year species. Scales (Coccidæ), or bark lice, were found in 17 stomachs, and in 5 they were identified as the plum or cherry scale (*Eulecanium cerasifex*). In 1 stomach this species amounted to 60 per cent of the contents. This shows that the bird forages to some extent among the smaller branches and twigs of live trees. A few individuals of several other families of bugs were found, of which Pentatomidæ, or stinkbugs, were the favorites.

Orthoptera, in the shape of grasshoppers, crickets, and cockroaches and their eggs, were eaten very sparingly throughout the year; but in August, the grasshopper month, the redhead takes to the ground, where it feeds quite freely upon these insects. They aggregate 21.17 per cent of its diet in August, and in September 9.53 per cent, amounting in the two months to two-thirds of the grasshoppers taken in the year. The average for the year is 3.58 per cent. There is much testimony that many grasshoppers are stored up for future use. They do not, however, constitute a very large element of the food after September. The redhead may share the instinct of its California cousin and store up much food that it never eats, thus contributing to the welfare of pilferers of the food.

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[1] Buchler, M. H., Pennsylvania Telephone Co., in letter to Biological Survey, dated Harrisburg, Pa., March 19, 1895.

[2] See Merriam, Bull. Nuttall Ornith. Club, III, 126, July, 1878; also Forest and Stream, IX, 451, January 17, 1878.

Lepidoptera, that is, caterpillars, are apparently not a favorite food of the redhead. A few were eaten in the months from April to October, inclusive, but in May only do they reach 10 per cent of the food. The average for the year is 1.63 per cent. One harmful species, the wheat-head army worm (*Heliophila albilinea*), was identified in one stomach, which contained about a dozen specimens. Dragonflies, spiders, and millepeds, bits of a crayfish, eggshells, and a few bits of bone and hair of some small rodent, altogether make up the remaining 1 per cent.

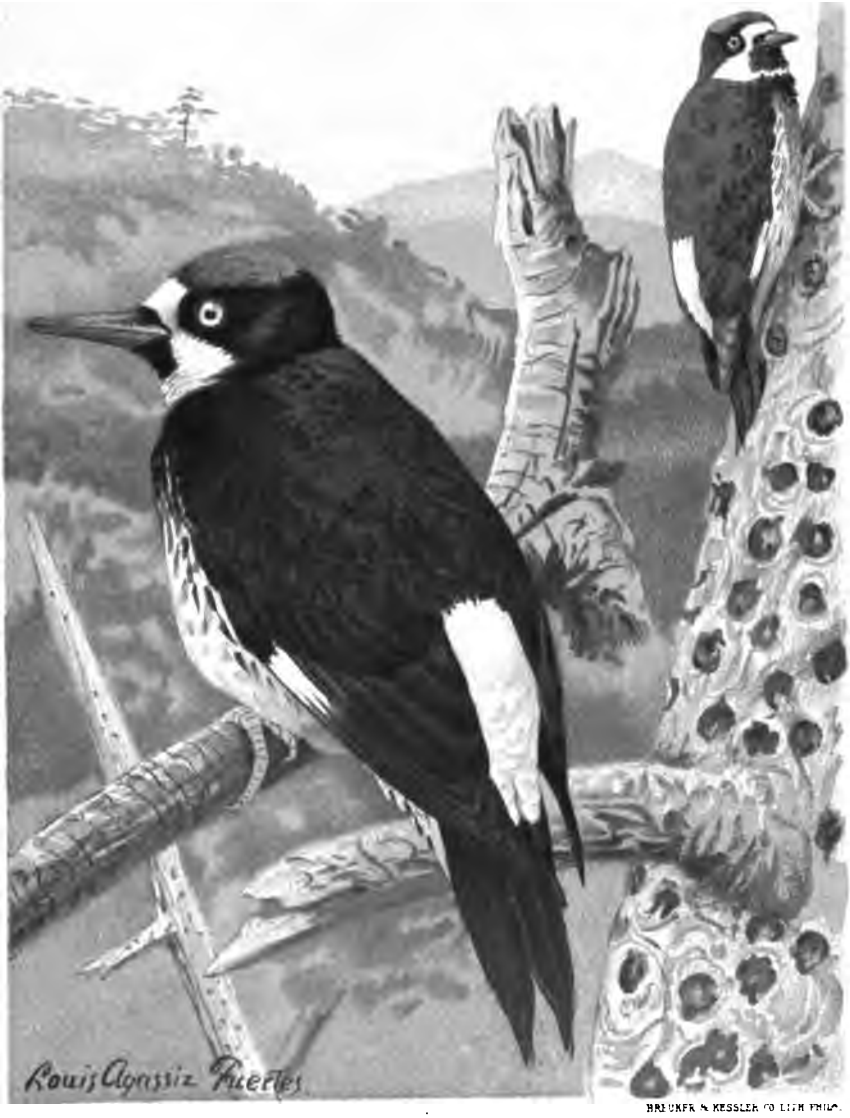
The following insects were identified in the stomachs of the redhead:

COLEOPTERA.

Cicindela sp.
Carabus sp.
Calosoma scrutator.
Calosoma calidum.
Pasimachus depressus.
Scarites subterraneus.
Pterostichus sayi.
Pterostichus sp.
Amara fulvipes.
Galerita janus.
Chlænius sp.
Geopinus incrassatus.
Agonoderus pallipes.
Anisodactylus discoideus.
Anisodactylus nigrita.
Anisodactylus sp.
Tropisternus sp.
Sphæridium scarabæoides.
Necrophorus sp.
Creophilus villosus.
Staphylinus vulpinus.
Staphylinus maculosus.
Coccinella 9-notata.
Ips fasciatus.
Melanotus fissilis.
Passalus cornutus.
Phanæus carnifex.
Canthon lævis.
Canthon sp.
Onthophagus sp.
Atænius cognatus.
Aphodius fossor.
Aphodius fimetarius.
Aphodius ruricola
Aphodius inquinatus.
Aphodius sp.
Bolboceras farctus.
Dichelonycha sp.
Macrodactylus subspinosus.
Lachnosterna sp.
Anomala sp.
Allorhina nitida.
Euphoria fulgida.
Euphoria inda.
Euphoria sepulchralis.
Prionus imbricornis.
Elaphidion sp.
Nodonota tristis.
Gastroidea cyanea.
Melasoma scripta.
Diabrotica 12-punctata.
Eleodes tricostata.
Meracantha contracta.
Corymbites cylindricollis.
Dicerca obscura.
Dicerca sp.
Chrysobothris sp.
Ptinus dubius.
Ceruchus piceus.
Epicauta sp.
Epicærus imbricatus.
Sitones sp.
Phytonomus punctatus.
Hylobius pales.
Balaninus sp.
Sphenophorus zeæ.
Sphenophorus sp.

HYMENOPTERA.

Apis mellifera.
Vespa maculata.
Ophion sp.
Camponotus sp.



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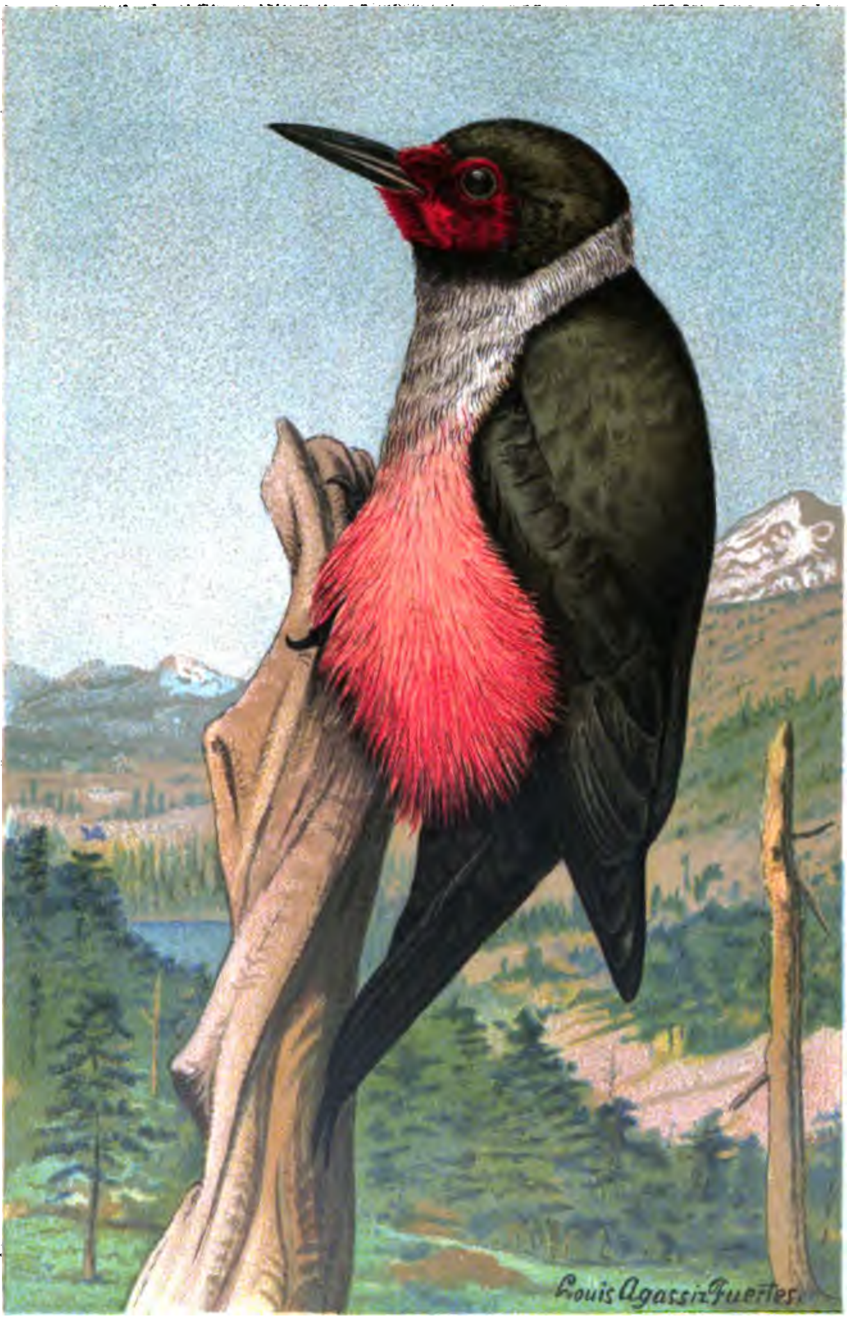
CALIFORNIA WOODPECKER.


Louis Agassiz Fuertes.

BREUKER & KESSLER CO. LITH. PHILA.

LEWIS WOODPECKER.

HEMIPTERA.

Nezara hilaris.
Sinea diadema.
Tibicen septendecim.
Tibicen sp.
Eulecanium cerasifex.

LEPIDOPTERA.

Wheat-head army worm (*Heliophila albilinea*).

Vegetable food.—Some grain is eaten by the redhead from May to September. In August and September it amounts to 21.73 and 19.67 per cent, respectively. The average for the year is 4.25 per cent. Corn was identified in 64 stomachs and oats in 2. The former was in most cases immature or in the milk, and was more or less mixed with corn silk. Domestic fruit was found in 175 stomachs—that is, if the seeds of blackberries and raspberries and the pulp without seeds were all of domesticated varieties. Blackberries and raspberries were identified in 42 stomachs, domestic cherries in 15, strawberries in 7, and apples in 9. Cultivated fruit was all taken in the months from April to September, inclusive, with the maximum of 16.76 per cent in July. The average for the year is 3.30 per cent. The above account undoubtedly does the bird great injustice, as probably most of the Rubus fruit (blackberries and raspberries) was obtained from wayside thickets, and it is almost certain that much of the unidentified pulp contained in 102 stomachs was from wild species. The strawberries also were as likely to be wild as cultivated. Wild fruits were found in 100 stomachs, and 17 species were identified. They were eaten in every month, the most in the colder ones. February appears to be the month of maximum consumption with 50 per cent, but the record is based on only 9 stomachs. The average for the year is 16.90 per cent. Anthers of flowers should perhaps be included in this item. They were found in 4 stomachs.

Mast is evidently a favorite food of the redhead. It appears in the stomachs of every month except March, but as only 3 were taken then the exception is probably accidental. The most was eaten in the four months from October to January, inclusive, and the average for those months is 55.22 per cent, and for the year 23.26 per cent. The great bulk of this is acorns, but some other nuts and large seeds are included. This record for mast eating is, as far as known, exceeded by only a few birds, notably the California woodpecker and the jays.

Miscellaneous vegetable matter amounts to 18.30 per cent. This is made up of cambium, found in 5 stomachs, poison-ivy seeds in 7, several other Rhus seeds, and a number of weed seeds. The great bulk of this item, however, is a mass of hard woody granules of very irregular shape and undetermined origin. They were found in 90 stomachs, and one contained nothing else. They have a resemblance to the woody granules in pear pulp, but are larger and more irregular. It is possible that they are derived from the pulp of some wild fruit. If so, their percentage should be added to the fruit pulp. They have been found in the food of other woodpeckers, but in comparatively small quantities.

The following fruits and seeds were identified:

Bristly greenbrier (*Smilax bona-nox*).
Mulberry (*Morus rubra*).
Dock (*Rumex* sp.).
Lambs quarters (*Chenopodium album*).
Shadbush or service berry (*Amelanchier canadensis*).
Bird cherry (*Prunus pennsylvanica*).
Chokecherry (*Prunus virginiana*).
Black cherry (*Prunus serotina*).
Dwarf sumac (*Rhus copallina*).
Smooth sumac (*Rhus glabra*).
Poison ivy (*Rhus radicans*).
Fox grape (*Vitis vulpina*).
Frost grape (*Vitis cordifolia*).
Woodbine (*Parthenocissus quinquefolia*).
Flowering dogwood (*Cornus florida*).
Rough-leaved dogwood (*Cornus asperifolia*).
Panicled dogwood (*Cornus candidissima*).
Sour gum (*Nyssa sylvatica*).
Huckleberry (*Gaylussacia* sp.).
Black nightshads (*Solanum nigrum*).
Black elderberry (*Sambucus canadensis*).
Red elderberry (*Sambucus pubens*).
Ragweed (*Ambrosia* sp.).

Summary.—No species of woodpecker in this country, with the possible exception of the yellow-bellied sapsucker (*Sphyrapicus varius*), has been the subject of so much adverse criticism as the redhead. It has been accused of eating nearly every variety of cultivated fruit from strawberries to oranges, of pecking corn from the ear, of eating the eggs of poultry and pigeons, of pecking open the skulls and devouring the brains of young poultry, and of destroying the eggs or young of eaves swallows and other birds. These accusations are well grounded, but the habits are probably only local. These reports have been received from hundreds of localities, but in thousands of other places where the bird abounds no such acts have been observed. Stomach examination confirms to some extent the corn-eating habit, and to a less degree the fruit-eating, but fails entirely to show that the bird habitually eats young birds or eggs.[1] Where this bird has done appreciable harm, it has probably been due to new and unusual conditions likely to be temporary. In its animal food the redhead does a little harm theoretically by its destruction of predatory beetles, but the harmful species eaten are enough to balance this. On the whole, there seems to be no reason to condemn this woodpecker except under very unusual conditions, and the man who claims to have killed 527 of them in four years did himself and neighbors a very doubtful service.

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[1] Eggshells have been found in some stomachs of nearly every species of bird yet examined by the writer. They are undoubtedly, in most cases, old shells eaten for the lime.

CALIFORNIA WOODPECKER.

(*Melanerpes formicivorus bairdi.*)

The California woodpecker (Pl. IV) is distributed throughout most of the oak-covered mountain and foothill region of California, northern Lower California, and southern Oregon. It lives generally wherever large oaks are abundant, and from these it gets much of its living. Wherever it occurs it is commonly abundant, and its strongly contrasted colors and loud cries attract much attention as it flies from tree to tree. A peculiar habit has drawn much notice from nonscientific observers—that of drilling holes in tree trunks or large branches, in each of which it places an acorn. Where this bird is abundant all dead trunks or branches of any size, and many live ones, are punctured with these holes, frequently less than an inch apart. So zealous is the bird in this work that often when trees in the proper condition for puncturing are not numerous enough, it attacks buildings and drills holes in the cornices of houses or in the spires of churches; also it bores into telephone and telegraph poles and fence posts, and sometimes uses natural cavities. But the woodpecker does not get the benefit of all the acorns it lays up, for the jays have learned where they can easily obtain food in winter, and are not backward about robbing the woodpecker's larder, thus causing endless quarrels. Probably rats, mice, and squirrels also help themselves to these supplies.

For the laboratory investigation of the food of the California woodpecker 84 stomachs were available. They were taken in every month except February, April, and May—the larger numbers in June and July, when the chances for the bird to do mischief are greatest. The food was found to consist of 22.59 per cent of animal matter to 77.41 per cent of vegetable. This is the highest percentage of vegetable matter yet found in the stomach of any woodpecker, though the red-bellied (*Centurus carolinus*) comes very close to it. Most other woodpeckers eat more animal than vegetable food.

Animal food.—Beetles constitute the smallest item in the animal food. They amount to less than 3 per cent, and are distributed among several families, with no preference shown for any one. In July, the only month in which they are at all prominent, they reach 14.76 per cent. No wood-boring larvæ were found. This seems to indicate that this bird uses its wood-pecking powers, not to find insects, but only to make places for storing food. Ants amount to 8.09 per cent of the food. In one stomach taken in March they constitute 50 per cent of the contents, but in no other do they reach 11 per cent. The specific name of this bird, *formicivorus*, is not well chosen, for it eats fewer ants than most other species of woodpeckers. Other Hymenoptera amount to 7.34 per cent. More than half of these were contained in stomachs taken in August, when they aggregate 37.33 per cent. A few bugs, flies, and grasshoppers, with some fragments of caterpillars, make up the remainder of the animal food—4.49 per cent. One stomach contained a few black olive scales.

Vegetable food.—Grain, fruit, and mast are the three items that form nearly all the vegetable food. One stomach taken in January contained nothing but corn, and in another collected in December were a few corn hulls. This is the whole of the grain record, and is of no economic interest. The average for the year but slightly exceeds 1 per cent. Fruit amounts to a little less than 23 per cent, and was found in nearly every month in which stomachs were taken. Most of it was evidently the pulp of the larger cultivated varieties, though that found in stomachs collected in the winter months could have no economic value. Seeds of the elderberry (*Sambucus*) were found in two stomachs and were the only fruit positively identified. The largest amounts were eaten in August and September, when they reached 59.34 and 54 per cent, respectively. While this is rather a high percentage of fruit eaten, complaints against the bird are not general, and the damage done to fruit over most of its range is probably comparatively small.

The principal item of the food of the California woodpecker is acorns. This amounts to 53.30 per cent of the food of the year, and was found in 58 stomachs, or 69 per cent of the whole, and 23 contained nothing else. It was eaten in every month when stomachs were taken except August, but as only 3 were collected in that month the record is not reliable. In November, when 12 stomachs were taken, acorns amounted to 93.58 per cent of the average contents. In June, when fruit and insects are abundant, it averaged in 12 stomachs 79.25 per cent. In July the least was eaten—29.47 per cent. This was made up by the animal food, which attained the highest percentage in that month. The question has been raised whether the bird stores the acorn for the sake of its meat or for the grubs which may frequently develop therein. The examination of the stomach contents removes all doubt, for while acorns are eaten freely larvæ are almost entirely wanting.

In certain localities where almonds are largely cultivated and this bird is abundant it exhibits a strong liking for these nuts. Under these conditions it is sometimes necessary to shoot every woodpecker that appears in the orchard in order to save even a reasonable part of the crop. Such conditions are likely to occur wherever large groves of oaks occur in close proximity to the orchards and this bird is correspondingly numerous. While the necessity for applying so drastic a remedy is unfortunate, it can be said that it is not so deplorable as it would be in the case of some other more conspicuously useful species.

Summary.—The foregoing discussion shows that the food of the California woodpecker is not of much economic importance. On the other hand, the bird can not be charged with destroying useful insects or many products of husbandry. While it eats considerable fruit, especially almonds, in fact twice as much as the linnet, it does not habitually infest orchards, and in most localities is not numerous enough to be a serious nuisance. The few insects which it takes are nearly all of harmful species, while the acorns which make up the bulk of its diet may be considered of little value. The trees used for storehouses are usually either dead or partly so, and when alive are little harmed by the punctures, which do not usually go through the bark. When, however, holes are made in buildings, telegraph or telephone poles, or fences, they are a real injury, and it is fortunate that such cases are local and exceptional. From the esthetic point of view, however, a strong plea for the bird's protection may be made. It is an interesting and picturesque species, and where it does not make itself conspicuous by reason of the damage it does it may well be allowed to live.[1]

LEWIS WOODPECKER.

(*Asyndesmus lewisi.*)

The Lewis woodpecker (Pl. V) is irregularly distributed over that part of the United States west of the eastern slope of the Rocky Mountains, north to southwestern Canada, and south to northern Mexico. In many localities within its range it is rare or absent, while very abundant in others. It is by nature somewhat shy, not greatly addicted to visiting orchards and cultivated areas.

In Oregon and Washington complaint has been made that the bird does some damage to apples. Only twice was the writer able to find cases of serious damage. An orchard situated close to a river, on the far side of which was a large area of wild land, was so persistently visited by Lewis woodpeckers, when the early apples were ripening, that the pickers were obliged to shoot the birds. One evening a number of boxes filled ready for market were left in the orchard. In the morning it was found that the woodpeckers had pulled out the papers and pecked the fruit so that it was necessary to open and repack several boxes. In the other case the orchard was in the foothills and almost completely surrounded by evergreen forests, from which the birds came and to which they retreated when alarmed.

Dr. Merriam, speaking of Fall River Valley, California, says of this bird: "Common everywhere and eating apples in several of the orchards." Also at Fort Jones: "Evidently eating apples."

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[1] Besides the California form, *bairdi*, treated of in these pages, there is at least one other, *aculeata*, within the limits of the United States. Its range is in the southern Rocky Mountains from central western Texas to northern Arizona. No stomachs of this subspecies have been received, but probably its food habits do not differ from those of the other form.

Messrs. Grant and Ferry, writing from Klamath Hot Springs, Oregon, say: "Abundant in flocks first part of September. Persons with guns stationed in orchards * * * to destroy these birds, kill 25 to 50 of them per day for from one to two weeks."

Mr. J. E. McLellam says they "never come in great numbers unless there is a good crop of mast, when they come in swarms. They hoard similar to the California woodpecker." Quite a number of apple growers interviewed by the writer testified that the bird destroyed some apples, but none of them considered the loss of any importance. As the orchards increase in area, the damage will probably become less.

Mr. W. Otto Emerson, of Haywards, Cal., in a letter to the Biological Survey, dated March 14, 1909, says of this bird:

> Several cases have come under my observation when in the fall months of September and October the California and Lewis woodpeckers have made their appearance in canyon apple orchards and went into them picking open the apples for the codling moth worms they contained, going all over the trees and taking such fruit as had a wormhole in it. In one orchard of about 2 acres in extent at Sunol, this county (Alameda), near the Niles Canyon, I counted 23 bodies of the Lewis woodpeckers and 9 of the California tied up to the limbs by the legs to frighten off the birds. The owner did not seem to know what the woodpeckers were after * * * till I called his attention to the condition of his wormy fruit.

For investigation of this bird's food only 59 stomachs were available. They were collected in five States from Montana and Wyoming westward to the Pacific coast. They are so irregularly distributed over the year as to make systematic study of the food impossible, but we may learn some of the elements which compose it. Animal matter amounts to 37.48 per cent and vegetable to 62.50 per cent.

Animal food.—Predaceous beetles were eaten to the extent of 6.72 per cent, and, as is usually the case, the most appear to have been taken in spring and early summer. They were made up of Carabidæ and Coccinellidæ (ladybird beetles). Of the former, the genus *Pasimachus* was recognized, and of the latter, two species, *Hippodamia convergens* and *H. 15-maculata*, were identified. Other beetles amount to 2.40 per cent and were all eaten in the five months from June to October. Among them were several Meloidæ, or blister beetles, not usually supposed to be very palatable. One specimen of a water beetle (*Philhydrus diffusus*) was also identified.

There is nothing in the stomachs to indicate that this bird ever digs into wood, decayed or otherwise, in search of beetle larvæ. Ants were eaten most in summer and in April, and June appears to be the month of maximum consumption, while May shows none. The average for the year is 11.87 per cent, but this can not be considered final. Other Hymenoptera reach 11.57 per cent. Hemiptera, or bugs, seem to be taken very sparingly, and those chosen were of the larger species. They amount to 1.36 per cent. Grasshoppers are eaten—not many in August, more in July, and most in September, with a trace in October, while the eastern birds eat the most of these insects in August. The average for the year is 3.20 per cent. No caterpillars or Lepidoptera in any form were found in this bird's stomach. A few spiders amount to less than half of 1 per cent.

Vegetable food.—Corn was found in one stomach taken in August, and constituted 62 per cent of its contents, but amounted to only 0.46 per cent of the food of the year. No other grain was found. Pulp and skins of fruit supposed to be of cultivated varieties were noted in March, the three summer months, and October. There is no certainty that all this was cultivated fruit, and in any event that taken in March could hardly have had any economic value. The aggregate for the year is 10.90 per cent. Wild fruit was identified in 26 stomachs, all of them taken in July, August, and September. In the former it amounted to over 63 per cent of the food, and the average for the year is 14.65 per cent. Six genera—*Amelanchier*, *Ilex*, *Crataegus*, *Cornus*, *Prunus*, and *Sambucus*—were identified. Mast, or acorns, is the largest item of food. It was found in 20 stomachs and constitutes 34.46 per cent of the diet. None was found in July, but in all the other months in which stomachs were taken it amounted to a good percentage. The one stomach taken in December contained 75 per cent of this food. Seeds of poison oak (*Rhus diversiloba*) and a weed (*Amaranthus*) make up 2.05 per cent, the remainder of the vegetable food.

Summary.—It is hardly possible to draw definite conclusions from so little material, especially when distributed over so large a territory. While the bird eats some useful beetles, probably it does no serious harm in this way. It is not likely to damage grain. Evidently, however, it has a pronounced taste for fruit, which at present is gratified mostly by wild species; but if the wild fruit-bearing shrubs and trees in its range should ever be replaced by cultivated varieties, it would doubtless turn to cultivated fruits. Further investigation in both field and laboratory are necessary in order to fix definitely the economic status of the Lewis woodpecker.

RED-BELLIED WOODPECKER.

(*Centurus carolinus.*)

The red-bellied woodpecker ranges over the eastern United States as far west as central Texas and eastern Colorado, and as far north as New York, southern Ontario, southern Michigan, and southern Minnesota. It breeds throughout this range and appears to be irregularly migratory. Very strangely, it often goes north of its breeding range to spend the winter. Four stomachs, collected in November and December, have been received from Canada, and in eight years of residence in central Iowa the writer found the species abundant every year during the winter, but never saw one in the breeding season. It is rather more of a forest bird than some of the other woodpeckers, but is seen frequently in open or thinly timbered country. In the northern part of its range it appears to prefer deciduous growth, but in the south is quite common in pine forests.

There is some evidence that this bird is occasionally injurious to the horticulturist. Dr. B. H. Warren says:

> In various sections of Florida, where the red-bellied woodpeckers are exceedingly numerous, in fact by odds the most abundant of all the woodpeckers, the common names of "orange sapsucker" and "orange borer" are universally applied to them. On making inquiry of farmers and others, I learned that the names were given because these woodpeckers "sucked the sap" of orange trees and fed on oranges. Supposing these statements were wrongfully made, I at first gave but little attention to them. When, however. I visited Welaka, Palatka, Volusia, Deland, and other places where numerous orange trees were thriving, I was informed by the orange growers that the red-bellied woodpeckers oftentimes destroyed large numbers of oranges when they had matured and were ready for picking; also, that "they damaged the orange trees by boring holes in them and sucking the sap." I had but little opportunity of making a careful study of this orange-eating habit, so greatly talked about, owing to the fact that when I first visited these localities it was late in February, or after the oranges had been picked and shipped north. In the month of March, 1885, I camped a few days at Bluffton, near Volusia, in an orange grove owned by Mr. Bird, of New York City. This grove contained about 30 acres of trees, which were loaded with fruit, then being picked for market. Through the kindness of Mr. Bird and his overseer, Mr. Curtis, I collected 26 red-bellied woodpeckers in this orange grove. Eleven of these birds had fed to a more or less extent on oranges.
>
> Three of the 11 stomachs taken from specimens killed in the forenoon, soon after daylight, contained only orange pulp. Eight stomachs showed, in addition to orange pulp, insects and berries. The stomachs of the remaining 15 birds contained no traces of oranges, but revealed chiefly insects, a few berries, and seeds. I examined two dozen or more oranges which had been attacked by the woodpeckers, and found that all had been bored about midway between the stem and blossom end. These holes, always round, varied greatly in size. The birds usually, I think, pick off the skin from a space about the size of an ordinary 5-cent piece, and then eat out the pulp. In an orchard at Hawkinsville, near Deland Landing, on the St. Johns River, I oftentimes, in the month of April, 1885, found oranges which had been evidently overlooked when the crop was gathered, and in most instances observed that they were bored. In this orchard on one occasion I saw a red-bellied woodpecker eating an orange. He evidently recognized the fact that it was about the last of the season, as he had enlarged the opening sufficiently so that his head was almost entirely hidden in the yellow skin, from the sides of which he picked the few remaining particles of pulp. I was shown orange trees that these "sapsuckers" were said to have bored. These borings, however, did not appear to injure the trees, as they seemed to me to be equally as flourishing as other trees whose trunks showed no marks of a woodpecker's bill.

Mr. William Brewster has made some observations on this point. He says:

> As corroborating Dr. Warren's account[1] in his late report on the birds of Pennsylvania, it may be worth while to state that when at Enterprise, Fla., in February, 1889, I observed a red-bellied woodpecker eating the pulp of a sweet orange. He flew down to the ground and, hopping along rather clumsily, approached an orange, and

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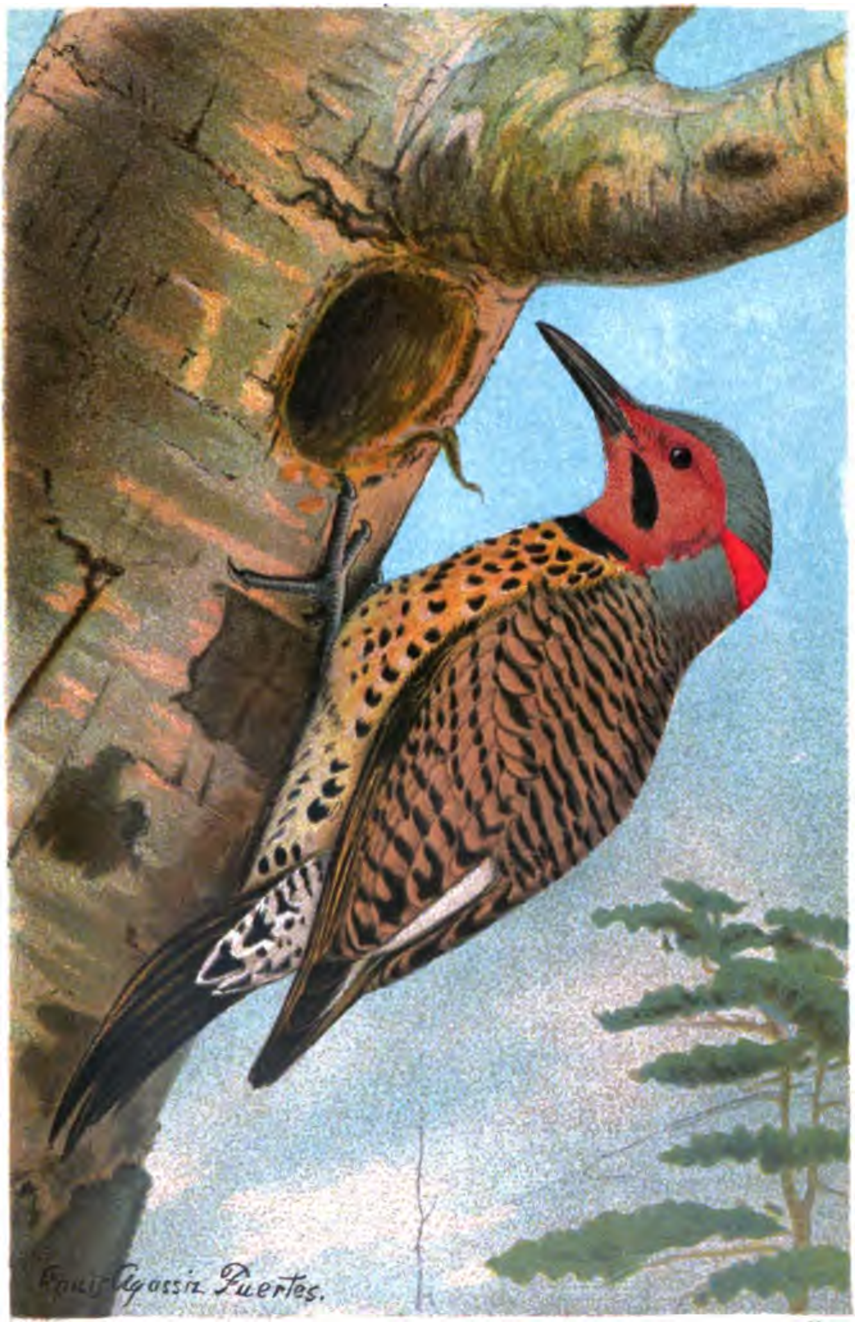
[1] Warren, B H., Birds of Pennsylvania, ed. 2, pp. 174-175, 1890.


Francis Agassiz Fuertes.

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FLICKER (ADULT MALE).

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> for several minutes pecked at it in a slow deliberate way. When I showed myself he at once took flight and sought shelter in the dense foliage of the trees above. Upon examining the orange I found that it was decayed through the whole of one side. In the sound portion were three holes, each nearly as large as a silver dollar, with narrow strips of peel between them. The pulp had been eaten out quite to the middle of the fruit. Small pieces of the rind were thickly strewn about the spot. Upon searching closely I discovered several other oranges that had been attacked in a similar manner. All were partially decayed and were lying on the ground. I was unable to find any on the trees which showed any marks of the woodpecker's bill. The owner of this grove was surprised when I called his attention to the above facts, which were quite new to him. Nor had any of the other orange growers in the neighborhood any knowledge of this orange-eating habit of the red-bellied woodpecker.[1]

Mr. Mortimer also gives testimony upon this habit of the bird:

> During February and March, 1889, while gathering fruit or pruning orange trees, I frequently found oranges that had been riddled by this woodpecker and repeatedly saw the bird at work. I never observed it feeding upon fallen oranges. It helped itself freely to sound fruit that still hung on the trees, and in some instances I have found 10 or 12 oranges on one tree that had been tapped by it. Where an orange accidentally rested on a branch in such a way as to make the flower end accessible from above or from a horizontal direction the woodpecker chose that spot, as through it he could reach into all the sections of the fruit, and when this was the case there was but one hole in the orange; but usually there were many holes around it. It appeared that having once commenced on an orange the woodpecker returned to the same one repeatedly, until he had completely consumed the pulp, and then he usually attacked another very near to it. Thus I have found certain clusters in which every orange had been bored, while all the others on the tree were untouched. An old orange grower told me that the "sapsuckers," as he called them, never touch any but very ripe oranges and are troublesome only to such growers as reserve their crops for the late market. He also said that it is only within a very few years that they have shown a taste for the fruit, and I myself observed that, although red-bellies were very common in the neighborhood, only an individual, or perhaps a pair, visited any one grove. In one case a pair took up their station in a dead pine near a grove and made excursions after the fruit at all hours of the day, being easily located by the noise they kept up.[2]

Dr. B. H. Warren states that the stomachs of three red-bellied woodpeckers captured in winter in Chester and Delaware Counties, Pa., contained black beetles, larvæ, fragments of acorns, and a few seeds of wild grapes. The stomachs of eight adults from the St. Johns River, Florida, contained red seeds of two species of palmetto, but no insects. Two additional stomachs from the same locality contained palmetto berries, fragments of crickets (*Nemobius* and *Orocharis saltator*), a palmetto ant (*Camponotus escuriens*), and numerous joints of a myriapod, probably *Julus*.[3]

Dr. Townend Glover found in the stomach of a red-bellied woodpecker killed in December "pieces of acorns, seeds, and gravel, but no insects. Another, shot in December, contained wing cases of *Buprestis*, and a species of wasp, or *Polistes*, acorns, seeds, and no bark. A third, shot in May, was filled with seeds, pieces of bark, and insects, among which was an entire *Lachnosterna*, or Maybug."[1]

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[1] Brewster, William, Auk, VI, 337-338. 1889.

[2] Mortimer, D. Auk, VII, 339-340, 1890.

[3] Birds of Pennsylvania, ed. 2, pp. 174, 178, 1890.

For the investigation of the food of the red-bellied woodpecker 271 stomachs were available. They were collected in 17 States and Ontario, and represent every month in the year, though but few were taken in June and July. In the first analysis the food was found to consist of 30.94 per cent animal matter to 69.06 of vegetable. The former consists of insects and spiders, with a few tree frogs and lizards, while the latter may be considered as made up of grain, fruit, and mast.

Animal food.—Predatory beetles (Carabidæ) amount to 0.86 per cent, and consist of some of the larger genera like *Pasimachus* and *Calosoma*. They were probably found on the bark of trees. Other beetles, all more or less harmful, aggregate 9.32 per cent of the food. Six species of weevils or snout-beetles were identified, and 14 individuals were taken from one stomach. There were also quite a number of wood-boring larvæ, which the birds must have dug out from the wood, thus benefiting the forest. Beetles form a pretty steady article of diet, and starting with 3.62 per cent in January they increase with fair regularity to May, when they attain the maximum of 27.57 per cent, from which they slowly decrease to 1 per cent in December.

Ants are eaten to the extent of 6.45 per cent of the food and are a fairly constant article of diet. The most are eaten during the warmer months, though none were found in the two stomachs taken in June, which is probably accidental. Evidently this bird does not dig all of the ants it eats from decaying wood, like the downy woodpecker, but, like the flickers, collects them from the ground and the bark of trees. Other Hymenoptera amount to 1.45 per cent, and while these insects are known to be great lovers of warmth and sunshine, most of them are eaten in fall and spring, and many even in winter, when they are usually less numerous. Orthoptera (grasshoppers, crickets, etc.) constitute 5.83 per cent of the food. They were found in 51 stomachs—grasshoppers in 27, eggs of cockroaches in 15, crickets in 8, and a mantis (devil's rear-horse) in 1. Two stomachs contained the eggs of grasshoppers, which indicates that this bird occasionally forages on the ground. Cockroaches were represented entirely by their egg cases (oötheca). These insects extrude their eggs, not singly like most other creatures, but packed together in a case somewhat like the clip of cartridges used for some modern breech-loading rifles. These cases are probably found by birds in crevices of the bark of trees. Orthoptera are eaten throughout the year, but in quantities varying greatly from month to month. In a general way, however, more were eaten in the summer season.

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[1] United States Agric. Rept. for 1865, p. 38, 1866.

Hemiptera, or bugs, amount to 1.86 per cent of the food, and form a small but fairly regular constituent of the monthly diet. Scales were found in one stomach, but most of the bugs eaten were of larger species, and the majority were Pentatomidæ or stink-bugs. Caterpillars were taken quite regularly, and average 2.88 per cent of the diet. A few of them were identified as wood-borers. Spiders and millepeds, with a few doubtful insects and small vertebrates, make up 2.29 per cent, the remainder of the animal food. Spiders were eaten at all times, but in trifling quantities. Small tree frogs were found in 9 stomachs and remains of a lizard (*Anolis carolinensis*) in 2. One stomach contained the lingual ribbon of a snail.

The following is a list of the insects identified:

COLEOPTERA.

Calosoma wilcoxi.
Pasimachus depressus.
Pasimachus sp.
Catogenus rufus.
Ips fasciatus.
Trogosita virescens.
Melanotus sp.
Passalus cornutus.
Dichelonycha sp.
Lachnosterna sp.
Nodonota puncticollis.
Hylobius pales.
Lixus sp.
Dorytomus mucidus.
Pseudomus truncatus.
Cryptorhynchus obliquus.
Balaninus sp.
Cratoparis lunatus.

HEMIPTERA.

Nezara hilaris.

Vegetable food.—Corn was the only grain found in the food of the red-bellied woodpecker. It was contained in 39 stomachs, rather irregularly distributed through the year, but none in the three summer months, April, or November. The great bulk was eaten in the three winter months and in March and September. In September it was undoubtedly from the green ear in the field, but the rest must have been waste. The total for the year is 3.99 per cent. Fruit amounts to 27.28 per cent and forms a notable percentage of the food in every month. The month of greatest consumption is August, with 64.10 per cent, while April shows the least, 7.50 per cent. The larger part of this consists of wild fruit, of which 23 species were identified. What was thought to be apple pulp was found in one stomach, cultivated grape in one, and blackberry or raspberry in one. Fruit pulp not further identified occurred in 15 stomachs and may have been of cultivated varieties. No great preference is shown for any one species of wild berry, but mulberries, woodbine, fox grapes, and sour gum were found in the most stomachs.

Mast amounts to 30.70 per cent and is the largest item of food. Acorns, beechnuts, hazelnuts, and pecans make up most of this item. It is eaten throughout the year except during the three summer months. It was found in 178 stomachs, and the greatest consumption appears to be in November, when it reached 67.05 per cent of the month's food, and it does not fall much below this figure until spring. This record for mast eating is the largest of that of any bird of this family except the California woodpecker. In most cases where birds eat much mast they habitually store up nuts and seeds for future use. The writer has been able to find but one reference to such a habit in this bird. W. L. Dawson, in Birds of Ohio, page 357, 1903, says it "lays up frugal stores of mast and corn." This seems quite probable, in view of what is found in the stomachs. Poison ivy seeds amount to 2.15 per cent and are eaten in every month from August to February, inclusive.

The following fruits and seeds were found in the stomachs:

Short-leaved pine (*Pinus mitis*).
Other pine seeds (*Pinus* sp.).
Saw palmetto (*Serenoa serrulata*).
Date palm (*Serenoa* sp.).
Greenbrier (*Smilax glauca*).
Bristly greenbrier (*Smilax bona-nox*).
Other greenbrier (*Smilax* sp.).
Bayberry (*Myrica carolinensis*).
Hackberry (*Celtis occidentalis*).
Red mulberry (*Morus rubra*).
Smartweed (*Polygonum* sp.).
Pokeberry (*Phytolacca decandra*).
Sassafras (*Sassafras sassafras*).
Blackberry or raspberry (*Rubus* sp.).
Wild black cherry (*Prunus serotina*).
Sumac (*Rhus glabra*).
Poison ivy (*Rhus radicans*).
American holly (*Ilex opaca*).
Swamp holly (*Ilex decidua*).
Frost grape (*Vitis cordifolia*).
Fox grape (*Vitis vulpina*).
Woodbine (*Parthenocissus quinquefolia*).
Prickly pear (*Opuntia* sp.).
Wild sarsaparilla (*Aralia nudicaulis*).
Flowering dogwood (*Cornus florida*).
Rough-leaved dogwood (*Cornus asperifolia*).
Panicled dogwood (*Cornus candidissima*).
Sour gum (*Nyssa sylvatica*).
Huckleberry (*Vaccinium* sp.).
Elderberry (*Sambucus canadensis*).
Ragweed (*Ambrosia* sp.).

Summary.—Only one element in the food of the red-bellied woodpecker has much economic significance. The bird evinces a decided taste for fruit, and sometimes injures orchards, as in Florida orange groves. The contents of the stomachs, however, show that wild fruits are the favorites, and probably only when these have been replaced by cultivated ones is any mischief done. Orange pulp was not positively identified in any stomach, though quite a number were collected in Florida during the orange season. Only a little of the grain eaten is taken when it is a loss to the farmer. In its animal food the bird is almost entirely beneficial, as the insects eaten are largely noxious.

FLICKER.

(*Colaptes auratus* subspp.)

The flicker (Pl. VI), known also as the golden-winged woodpecker, yellow-shafted woodpecker, high-holder, yellow-hammer, pigeon woodpecker, and hairy-wicket, is one of the most widely distributed and best known species in the United States. This is one of the few woodpeckers whose flesh is considered palatable, and a few years ago large numbers were shot for market every fall when wild black cherries were ripe. The bird is so fond of this fruit that when feeding in the trees it loses its natural shyness and is easily approached and killed. Fortunately it is now protected by law in most of the States, and it should be in all. It is a bird of the open country rather than of the forest. It is much more wary than the hairy or downy. It visits the orchard regularly, but does not make serious inroads on the fruit, and it forages much upon the ground—in fact, in spite of its liking for tall trees, the flicker is the most terrestrial of American woodpeckers.

This species is distributed over the whole of the eastern United States and north to Canada and Alaska, and is replaced in the West by the red-shafted flicker. The two forms meet on the Great Plains and along the eastern edge of the Rocky Mountain region and intermingle in all degrees of hybridism. Typical specimens of either species are frequently taken far within the range of the other, as, for instance, a perfect *Colaptes auratus* was collected by the writer a few miles east of Haywards, Cal., while typical *C. cafer collaris* can be taken every winter at Ames, Iowa. With the possible exception of the yellow-bellied woodpecker, the eastern flicker is the most migratory American species. In winter it is rarely seen in New England and only in small numbers in the other northern States. As it breeds abundantly in Canada, it becomes very numerous in the northern tier of States in fall when migrating. At this time it subsists largely upon wild cherries and other wild fruits.

The flicker rears from 6 to 10 young in each brood. The nest is built in a cavity excavated in a partially decayed tree, and is often quite elaborate, but in some cases it is in a hole caused by natural decay, where little or no preparatory work is required. The young find their voices very early in life, and by the time they are a week old make a great outcry every time they receive a visit from their parents or even hear approaching footsteps.

Complaints have been made that the flicker eats corn and cultivated fruit to an injurious extent, but the charges are not very specific, and the stomach contents do not indicate extensive depredations of this kind.

For the investigation of the food of the eastern flicker, 684 stomachs were available. They were collected in 35 States, the District of Columbia, and Canada, and are very evenly distributed through the year. The food consists of 60.92 per cent of animal matter to 39.08 of vegetable. In addition the stomachs contain considerable fine sand, which is probably not taken to aid digestion, but is swallowed accidentally with some kinds of food, notably ants. Quite a quantity of vegetable rubbish is taken in the same way.

Animal food.—Predaceous ground beetles (Carabidæ) form a small but very constant element of the flicker's food. Among those eaten are some of the larger and more predatory genera, such as *Calosoma*, *Scarites*, and *Pterostichus*. The total amount eaten in the year is only 1.62 per cent of the food, and in August, the month of greatest consumption, it rises to only 3.79 per cent. Other beetles are found in the food of every month, but in rather irregular amounts. The aggregate for the year is 3.52 per cent. The favorite food of the flicker, however, is ants. They form the largest item of animal food, not only in the aggregate but in every month. The total for the year is 49.75 per cent of the food. They were found in 524 of the 684 stomachs, i. e., in 76 per cent of the whole, and there were 98 stomachs that contained no other food. The following table shows the importance of ants in the diet of the flicker:

Months.	Number of stomachs.	Per cent of ants in food.	Number of stomachs with ants.	Per cent of stomachs with ants.	Number with no other food.
January	34	24.09	20	58.8	
February	55	29.73	31	56.3	4
March	37	79.14	32	86.5	14
April	75	80.17	70	93.3	21
May	33	79.24	32	96.9	9
June	31	79.19	30	96.8	9
July	51	70.74	47	92.1	13
August	92	61.47	84	91.3	12
September	138	42.61	108	76.1	12
October	54	21.79	31	57.4	2
November	41	17.37	22	53.6	1
December	43	11.46	17	39.5	1
Total	684		524		98
Average per month		49.75		74.9	

In one case a stomach and crop were both filled with very small ants (*Cremastogaster* sp.). The whole mass was divided with care into 16 parts as nearly equal as possible, and in one part 315 ants were counted, giving 5,040 in one meal of one flicker. In addition there were at least 100 pupæ. Two other stomachs and crops examined in the same way each gave a little over 3,000 ants. Probably each of 100 stomachs in the collection contained nearly as much ant food as these, but the number of ants was less because they were of larger species. A large proportion of the ants eaten are of species that live in the earth, and these appear to be the principal food the flicker obtains on the ground. In every case where the stomach held a quantity of these small ants, a lot of fine sand revealed their source.

Since the flicker destroys so many ants, it may be well to inquire as to the economic bearing of this work. As a rule we do not hear many serious complaints against ants. They do not attack crops or manufactured products. Probably they do some good by devouring dead matter, both animal and vegetable, and in this way hasten the decay of dead trees. On the other hand, some species enter houses and become a positive nuisance, as, having their nest in an inaccessible place, it is almost impossible to destroy them. Other species establish colonies in lawns or gardens and are so persistent that nothing short of digging out and carrying off the whole area of earth which they have preempted will rout them from their chosen home. When timber has been injured by wood-boring beetle larvæ, ants enlarge the burrows and in a few years riddle and spoil the whole trunk. The worst sin of the ants, however, is that they protect and foster plant lice in every possible way. They defend them from their enemies, cover them with sheds to shield them from inclement weather, and upon the approach of winter they carry some species into the ground and place them on the roots of plants for the winter and at the return of warm weather bring them to the upper air and place them in a position suitable to their needs. As plant lice constitute one of the worst pests to horticulture, their protectors are a nuisance and should be destroyed. As we have seen, flickers devour enormous numbers of them and aid essentially in holding them in check. Hymenoptera other than ants amount to only four one-hundredths of 1 per cent of the yearly food.

Bugs (Hemiptera) are eaten in nearly every month, but only in small quantities. In January, February, and May they reach an average of about 3 per cent, but in no other month do they amount to even 1 per cent. One stomach contained scales not further identified, another held 17 chinch bugs (*Blissus leucopterus*), and in another were what were probably the same in an early stage of growth. Two stomachs contained each a single bedbug (*Cimex lectularius*), probably taken on trial and not relished. Cicadas, or harvest flies (*Tibicen rimosa*), were found in several stomachs. The aggregate of Hemiptera for the year is only 0.85 per cent.

Orthoptera, in the shape of grasshoppers, crickets, and cockroaches, amount to 2.39 per cent. They are eaten in every month, but not very regularly. Singularly, the maximum quantity was taken in January, 9.77 per cent, which is more than twice the amount in any other month. This record, however, was made by birds taken in Texas, which had partaken freely of crickets. The least consumption occurs in August, the grasshopper month, which shows that the flicker is not a lover of grasshoppers.

Lepidoptera, in the form of caterpillars, are eaten very sparingly—in fact in only three months do they amount to as much as 1 per cent. In August they reach 4.91 per cent, 3.13 in June, and 3.29 in November. The only one identified was the common zebra caterpillar of the gardens (*Mamestra picta*). The total for the year is 1.28 per cent. A few fly larvæ, spiders, myriapods, crustaceans, and snails make up the rest of the animal food. Larvæ of Tipulidæ (crane flies) were found in 3 stomachs and *Bibio* larvæ (March flies) in 2. As these creatures breed in the earth, this again shows the terrestrial habits of the flicker. Spiders and myriapods were found in a good many stomachs, but few were taken at one time, so the aggregate is not large. Crustaceans, in the form of *Oniscus* (sowbugs), were found in 5 stomachs. Snail shells, mostly fragments, were of frequent occurrence, and one was identified as *Zonitoides minusculus*. The total of these miscellaneous creatures is 1.49 per cent, which completes the record of animal food.

The following is a list of the insects identified in the stomachs:

COLEOPTERA.

Cicindela vulgaris.
Calosoma calidum.
Elaphrus obliteratus.
Scarites subterraneus.
Pterostichus sayi.
Amara exarata.
Amara impuncticollis.
Amara angulata.
Calathus ingratus.
Platynus placidus.
Platynus punctiformis.
Brachynus puberulus.
Chlænius sp.
Agonoderus pallipes.
Harpalus faunus.
Harpalus pennsylvanicus.
Harpalus pleuriticus.
Harpalus ellipsis.
Anisodactylus rusticus.
Anisodactylus sp.
Stenus shoshonis.
Quedius prostrans.
Stelidota 8-maculata.
Melanotus communis.
Copris minutus.
Onthophagus hecate.
Onthophagus sp.
Aphodius fimetarius.
Aphodius inquinatus.
Aphodius bicolor.
Aphodius sp.
Lachnosterna sp.
Ligyrus sp.
Caryoborus arthriticus.
Opatrinus aciculatus.
Blapstinus pruinosus.
Blapstinus pulverulentus.
Blapstinus sp.
Tanymecus confertus.
Sitones hispidulus.
Phytonomus punctatus.
Sphenophorus sp.

HYMENOPTERA (ANTS).

Formica obscuripes.
Formica nitidiventris.
Formica subsericea.
Formica subpolita.
Formica gagates.
Formica subænescens.
Formica sp.
Lasius claviger.
Lasius aphidicola.
Lasius brevicornis.
Lasius americanus.
Lasius alienus.
Lasius miniatus.
Lasius subniger.
Lasius sp.
Camponotus marginatus.
Camponotus melleus.
Camponotus pennsylvanicus.
Camponotus minutus.
Camponotus pictus.
Camponotus sp.
Myrmica scabrinodis.
Myrmica sabuleti.
Myrmica sp.
Cremastogaster læviuscula.
Cremastogaster minutissima.
Cremastogaster sp.
Aphænogaster picea.
Aphænogaster fulvum.
Aphænogaster treatæ.
Aphænogaster sp.
Prenolepis imparis.
Pheidole sp.
Solenopsis geminata.
Solenopsis debilis.
Tetramorium sp.

HEMIPTERA.

Zelus renardi.
Blissus leucopterus.
Metapodius sp.
Tibicen rimosa.
Cimex lectularius.

DIPTERA.

Bibio sp.
Tipula sp.

LEPIDOPTERA.

Mamestra picta.

ORTHOPTERA.

Gryllus sp.
Ischnoptera sp.

ISOPTERA.

Termes flavipes.

CRUSTACEA.

Oniscus sp.

MOLLUSCA.

Parastarte triquetra.
Zonitoides minusculus.

Vegetable food.—Corn was found in 17 stomachs of the flicker, wheat in one, and buckwheat in two. One stomach taken in March was entirely filled with corn, evidently waste grain. Most of the remainder was taken in fall and early winter. The total for the year is 1.12 per cent. Small fruits are the favorite vegetable food with this bird. They are eaten in every month and constitute a good percentage in all but two. In April and May fruit amounts to less than 1 per cent, but increases through the summer to October, when it is about 42 per cent of the food, and then decreases gradually to the minimum in April. Possibly some of the Rubus fruits were cultivated, and the cherries in one stomach certainly were, while the fruit pulp in 21 stomachs may have been, but in any case the amount is insignificant and shows that the flicker eats but little domestic fruit. On the other hand, 31 species of wild fruits were identified. They were contained in 265 stomachs, and 40 contained no other food. They are not only the favorite vegetable food, but, next to ants, are the favorite food of the year. There is also shown a fondness for the seeds of various species of poisonous *Rhus* (poison ivy, poison oak, and poison sumac). These seeds are eaten mostly in the fall and winter months, when small fruits are less abundant. May, June, and July are the only months when none were eaten. November appears to be the month of greatest consumption, when they reach nearly 38 per cent. The aggregate for the year is 9.25 per cent.

Mast, if the term be limited to acorns and other nuts, is not a favorite food of the flicker. It is eaten to some extent in the three winter months and occasionally tasted at other times. It amounts to 1.79 per cent of the food. Cambium, weed seed, nonpoisonous *Rhus* seeds, and rubbish are found in some stomachs pretty regularly through the year, though the quantity is very irregular. It would appear that the three former are eaten only in default of anything better, and the last is probably taken accidentally when seeking ants in rotten wood or under rubbish. The total amount is 6.64 per cent and completes the quota of vegetable food.

The following fruits and seeds were identified:

	Number of stomachs containing
Hemlock (foliage) (*Tsuga canadensis*)	1
Red cedar (*Juniperus virginiana*)	5
Barnyard grass (*Panicum* sp.)	1
Foxtail grass (*Ixophorus* sp.)	2
Glaucous-leaved greenbrier (*Smilax glauca*)	1
Cat brier (*Smilax rotundifolia*)	1
Bristly greenbrier (*Smilax bona-nox*)	1
Laurel-leaved brier (*Smilax laurifolia*)	3
Bayberry (*Myrica carolinensis*)	48
Sweet fern (*Comptonia peregrina*)	1
Beech (*Fagus americana*)	1
Hackberry (*Celtis occidentalis*)	24
Mulberry (*Morus rubra*)	2
Pale persicaria (*Polygonum lapathifolium*)	1
Lady's thumb (*Polygonum persicaria*)	1
Black bindweed (*Polygonum convolvulus*)	1
Smartweed (*Polygonum* sp.)	4
Pokeweed (*Phytolacca decandra*)	5
Magnolia (*Magnolia foetida*)	3
Spicebush (*Benzoin benzoin*)	2
Sand blackberry (*Rubus cuneifolius*)	1
Blackberry or raspberry (*Rubus* sp.)	15
Juneberry (*Amelanchier canadensis*)	3
Wild black cherry (*Prunus serotina*)	30
Chokecherry (*Prunus virginiana*)	7
Crab cherry (*Prunus avium*)	1
White clover (*Trifolium repens*)	6
Crane's-bill (*Geranium* sp.)	1
Croton (*Croton* sp.)	1
Dwarf sumac (*Rhus copallina*)	3
Smooth sumac (*Rhus glabra*)	11
Poison sumac (*Rhus vernix*)	5
Poison ivy (*Rhus radicans*)	82
Poison oak (*Rhus diversiloba*)	1
Sumac (*Rhus* sp.)	11
American holly (*Ilex opaca*)	1
Dahoon holly (*Ilex cassine*)	1
Ink berry (*Ilex glabra*)	8
Swamp holly (*Ilex decidua*)	1
Black alder (*Ilex verticillata*)	4
Burning bush (*Euonymus* sp.)	1
Frost grape (*Vitis cordifolia*)	22
Flowering dogwood (*Cornus florida*)	16
Rough-leaved dogwood (*Cornus asperifolia*)	1
Alternate-leaved dogwood (*Cornus alternifolia*)	1
Sour gum (*Nyssa sylvatica*)	32
Large tupelo (*Nyssa aquatica*)	2
Huckleberry (*Gaylussacia* sp.)	6
Blueberry (*Vaccinium* sp.)	7
Black nightshade (*Solanum nigrum*)	1
Mullein (*Verbascum thapsus*)	1
Black elderberry (*Sambucus canadensis*)	11
Red elderberry (*Sambucus pubens*)	1
Ragweed (*Ambrosia artemisiifolia*)	3

Summary.—From the point of view of the food analyst the farmer and horticulturist have very little quarrel with the flicker. It eats only a few predaceous ground beetles. The remainder of the animal food is entirely of harmful species. In its vegetable diet, grain and fruit are the only useful products eaten, and the quantities are insignificant. The bird, like many others, has the bad habit of sowing broadcast the seeds of the poison Rhus, but there seems no remedy for this.

RED-SHAFTED FLICKER.

(*Colaptes cafer collaris* and other subspp.)

The red-shafted flicker inhabits that part of North America westward from the Great Plains, where its range meets that of the golden-winged woodpecker. Typical specimens of *Colaptes cafer collaris* are found as far east as South Dakota, central Iowa, and central Texas. The writer took them in winter at Ames, Iowa, for several years in succession. The eastern and western forms of the flicker nest in the same kind of places, their voices and manner of flight are the same, as are their methods of feeding, and practically their food. The differences of plumage can be certainly distinguished only when the bird is near. The western species has one habit which the eastern one rarely shares, that of pecking holes in cornices and cupolas in order to prepare a winter home. As most of the eastern flickers migrate in winter, the few that remain usually find lodging places in trees. In California, where the birds do not migrate in winter; much complaint has been made against them for disfiguring and injuring buildings.

For the investigation of the food of the red-shafted flicker 183 stomachs were available. They were collected in 10 States and in British Columbia, but more than three-fourths of them came from California. They are distributed through every month of the year, but the warmer seasons are represented by entirely too few. The food was found to consist of 67.74 per cent of animal matter to 32.26 of vegetable. This is over 6 per cent more animal food than is eaten by the eastern species. This difference occurs almost entirely in the winter months, when, in the East, the ground is more or less covered with snow and insects are not readily obtained, while seeds and berries are still accessible.

Animal food.—Useful Coleoptera, i. e., predaceous ground beetles, amount to 3.89 per cent of the food, but appear to be eaten very irregularly. In January and March they amount to 17 per cent of the food and in November to 7.28 per cent. In two months they barely reach 1 per cent, and in all the others they are but a trace or do not appear at all. This would seem to indicate that these insects are taken only when better food is not at hand. Other beetles amount to 2.66 per cent. They are largely Scarabæidæ or May beetles, most of them in the larval stage. The larvæ live to a great extent in rotten wood and rubbish, and some species that live on plant roots are often turned up by the plow. They seem to form quite a constant element of the food of both species of flicker. Ants are the favorite food of this bird as well as of its eastern relative. They aggregate 53.82 per cent of the food, which is more than 4 per cent higher than the record of *auratus*, though it is doubtful if this difference would hold with a larger number of stomachs. In May only one stomach of *cafer* was taken, and it was entirely filled with ants. Like those eaten by *auratus*, these ants are to a great extent taken from the ground, and the usual quantity of sand was found with them. Ants were found in 127 of the 183 stomachs, and 23 contained no other food. Besides the sand ants, some of the large species that live in decaying trees and logs were eaten. These of course are dug out of their burrows. Hymenoptera other than ants are eaten by this bird so rarely as to be negligible.

Hemiptera, or bugs, constitute 1.84 per cent of the flicker's diet, but they are so far from being a favorite food that they were found in the stomachs collected in only 4 months—January with 1.92 per cent, April with 12.50 per cent, June with 7.50 per cent, and October with 0.14 per cent. In each of these months the insects were contained in only one stomach and in April and June were all cicadas, or harvest flies, but in the January stomach they consisted of those curious and delicate looking creatures called lace bugs (Tingitidæ). Caterpillars amount to 2.12 per cent of the food and are mostly eaten in the winter and spring months. This is probably owing to the fact that the species taken are mostly wood borers and are dug out of decaying wood in the colder season. March is the month of greatest consumption with 9.11 per cent, and December next with 8.84 per cent. The amount in the other months is small.

Orthoptera aggregate 1.45 per cent and consist of crickets with a few bits of grasshoppers and locusts. They are all taken from October to February inclusive, which shows that this bird, although so terrestrial in its habits, does not join in the grasshopper feast in summer. White ants (*Termes*), a few other insects, and spiders collectively amount to 1.96 per cent and complete the animal food. *Termes* are very similar in habits to the true ants, and are often found and devoured by woodpeckers in their search for ants. Like true ants, white ants do much mischief by boring into timber, and are not infrequently found in the woodwork of buildings, which they sometimes greatly injure, even to the extent of threatening the stability of the structure.

The following insects were identified in the stomachs:

COLEOPTERA.

Pterostichus permundus.
Evarthrus orbatus.
Amara insignis.
Calathus ruficollis.
Platynus maculicollis.
Axinopalpus biplagiatus.
Harpalus herbivagus.
Harpalus sp.
Anisodactylus dilatatus.
Anisodactylus piceus.
Chœridium histeroides.
Diabrotica soror.
Anthonomus sp.
Calandrinus grandicollis.

HYMENOPTERA (ANTS).

Formica subpolita.
Formica neorufibarbis.
Formica obscuriventris.
Formica obscuripes.
Formica sp.
Camponotus marginatus.
Lasius americanus.
Lasius sp.
Cremastogaster lineolata.
Cremastogaster sp.
Solenopsis geminata.
Prenolepis imparis.
Myrmica lobicornis.
Myrmica sp.
Messor andrei.

CRUSTACEA.

Sowbug (*Porcellio scaber*).

MOLLUSCA.

Snail (*Lymnæa columella*).

Vegetable food.—Fruit was eaten to the extent of 10.28 per cent of the red-shafted flicker's food. It appears to be taken rather irregularly, but probably examination of a greater number of stomachs would show it to be a pretty regular article of diet, as the eastern flicker is a constant fruit eater. The greatest amount is taken in November, when it aggregated 31.84 per cent. September stands next with 23.75 per cent. Like the eastern species, this bird eats more fruit in fall and winter than in the warmer months. Grapes were identified in 12 stomachs, and probably nearly all were of cultivated varieties. Domestic cherries were found in one stomach, what was thought to be apple pulp in 9, and fruit pulp not further identified in 11. This is the whole list of cultivated fruit, if we suppose the last item to have been of domestic varieties, but as the greater part of it was taken in the winter or late fall months, probably little harm was done. Wild fruits of 6 varieties were found in 10 stomachs. There appear to be less small fruits or berries available for bird food on the western side of the Rocky Mountains than on the eastern. This is well illustrated in the diet of the two flickers; the eastern species has 31 kinds of wild fruit in its bill of fare to 6 of the western bird. This difference has been noted in the food of other closely allied species, one from the East and the other from the West.

Grain amounts to 2.26 per cent of the food. It was found in January, August, October, and November, and consisted of corn in 14 stomachs, barley in 1, and oats in 1. The barley and oats were taken in January, and were therefore waste grain. The corn must have been obtained from the standing crop, and indeed much of it had been eaten while in the milk. This is not, however, a heavy indictment against the flicker and may well be excused. Seeds of various shrubs and herbs and some rubbish amount to 19.59 per cent, and make up the quota of vegetable food. The largest part of this item consists of seeds of the different poisonous Rhuses, commonly known as poison ivy or poison oak. They are probably eaten in every month, though the one stomach taken in May did not contain any. They were found in 51 stomachs and formed a staple article of diet in all the cooler months, and in December amounted to more than half the food. It is in the distribution of these seeds, if anywhere, that the flickers do harm. Seeds of the nonpoisonous Rhuses (sumac) and of various weeds were eaten occasionally but not in great quantities. Mast in the shape of acorns was found in 16 stomachs, and is probably very acceptable in the absence of better food.

The following fruits and seeds were identified:

Pigweed (*Amaranthus* sp.).
Purslane (*Portulaca* sp.).
Gooseberry (*Ribes menziesi*).
Bur clover (*Medicago denticulatum*).
Filaree (*Erodium cicutarium*).
Poison ivy (*Rhus radicans*).
Poison ivy (*Rhus aromatica*).
Poison oak (*Rhus diversiloba*).
Sumac (*Rhus* sp.).
Pepper berry (*Schinus molle*).
Woodbine (*Parthenocissus quinquefolia*).
Dogwood (*Cornus pubescens*).
Elder (*Sambucus glauca*).
Sunflower (*Helianthus* sp.).
Star thistle (*Centaurea calcitrapa*).
Bur thistle (*Centaurea melitensis*).

Summary.—The above analysis of the food shows that the farmer and horticulturist have little to fear from the red-shafted flicker. In its animal diet it does very little harm, and it consumes no more of the products of husbandry than it is entitled to. Its greatest fault is distributing seeds of the poisonous Rhuses, a sin which it shares with so many other birds that there is no occasion for invidious comparisons.

IVORY-BILLED WOODPECKER.

(*Campephilus principalis.*)

The ivory-billed is the largest woodpecker inhabiting the United States. Unfortunately, it appears to be rapidly becoming extinct. It originally occupied all the heavily wooded bottom lands from eastern Texas east to the Atlantic and from southern Indiana and Illinois south to the Gulf. At present it is confined to the lower Mississippi Valley and Gulf States and is nowhere numerous.

Only two stomachs of this species have been available for examination. The contents of these are discussed in detail because of the interest that attached to this magnificent but vanishing bird rather than its present economic importance. One stomach contained 32 and the other 20 of the wood-boring cerambycid larvæ, which live by boring into trees. These constituted 37.5 per cent of the whole food. The remainder of the animal food consisted of engraver beetles (*Scolytidæ*) found in one stomach. Of these, three species were identified—*Tomicus avulsus*, *T. calligraphus*, and *T. grandicollis*. The total animal food amounted to 38.5 per cent.

The vegetable food consisted of fruit of *Magnolia fœtida* in one stomach, and of pecan nuts in the other. The average for the two was 61.5 per cent. This analysis of food indicates that the species, except for its small numbers, might be of considerable economic value, as the insects forming the animal portion of the food are mostly of an injurious character. These powerful birds are able to reach the wood-boring grubs in places where smaller species fail, and their large bodies require a great quantity of such food. The vegetable portion of the food does not indicate that the bird is likely to attack any products of agriculture, an inference which is strengthened by its shy, retiring habits. It is preeminently a wilderness lover and avoids cleared and cultivated districts.

When we see how much good this woodpecker is capable of doing as a guardian of the forest, it seems deplorable that it should be allowed to be exterminated. Wise legislation, backed by intelligent public opinion, may retard, if not absolutely prevent, the present destruction and allow the bird to regain something of its former abundance. There is plenty of room for this splendid species and much need of its services in the great southern forests.

OTHER WOODPECKERS.

Besides the species of woodpeckers whose food has been discussed in the preceding pages, a few stomachs of 5 other species have been received, and, while there are too few to warrant a general discussion of their food, some mention of its most prominent characteristics may be made. The following table gives the number of stomachs of each species and the percentage of animal and vegetable food for each:

Name of species.	Number of stomachs.	Animal food.	Vegetable food.
Texan woodpecker (*Dryobates scalaris bairdi*)	14	92.07	7.93
White-headed woodpecker (*Xenopicus albolarvatus*)	14	38.93	61.07
Golden-fronted woodpecker (*Centurus aurifrons*)	11	54.73	45.27
Gila woodpecker (*Centurus uropygialis*)	1	40.00	60.00
Gilded flicker (*Colaptes chrysoides*)	5	88.00	12.00

The Texan woodpecker (*Dryobates s. bairdi*) shows the ruling characteristic of the genus in its food, for the largest item is wood-boring beetle larvæ. Caterpillars are second in importance, and include a number of cotton worms (*Alabama argillacea*), which were found in some stomachs collected in Texas. Ants are next in rank, and these three items make up the bulk of the food.

Half of the animal food of the white-headed woodpecker (*Xenopicus albolarvatus*) is ants, but the most pronounced characteristic of this bird is its fondness for the seeds of pines, which constitute more than half of the food.

The golden-fronted woodpecker (*Centurus aurifrons*) shows a decided taste for grasshoppers, which make up half of its animal food. Its vegetable diet is composed almost entirely of small fruits or berries.

The one stomach of the Gila woodpecker (*Centurus uropygialis*) was largely filled with beetles of the May-beetle family, with a few bones of a lizard. The vegetable part was mere refuse.

The gilded flicker (*Colaptes chrysoides*) shares the characteristic fondness of the genus for ants, which constitute three-fourths of the whole food. The vegetable part was mostly mast.

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